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THE

EDINBURGH

PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF

THE PROGRESS OF DISCOVERY IN NATURAL PHILOSOPHY, CHEMISTRY, NATURAL HISTORY, PRACTICAL MECHANICS, GEOGRAPHY, NAVIGATION, STATISTICS, AND THE FINE AND USEFUL ARTS,

FROM

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TO BE CONTINUED QUARTERLY.

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THE

EDINBURGH
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THE distribution of heat over the Globe belongs to that kind of phenomena, of which the general circumstances have been long known, but which were incapable of being rigorously determined or submitted to exact calculation, till experience and observation furnished data from which the theory might obtain the corrections and the different elements which it requires. The object of this memoir is to facilitate the collection of these data, to present results drawn from a great number of unpublished observations, and to group them according to a method which has not yet been tried, though its utility has been recognised for more than a century in the exposition of the phenomena of the variation and dip of the magnetic needle. As the discussion of individual observations will be published in a separate work, I shall at present limit myself to a simple sketch of the distribution of heat over the globe, according to the most recent and accurate data. Although we may not be able to refer the complex phenomena to a general theory, it will be of considerable importance to fix the numerical relation by which a great number of scattered observations are connected, and to reduce to empirical laws the effects of local and disturbing causes. The study of these laws will point out to travellers the problems to which they should direct their principal attention, and we may entertain the hope, that the theory of the distribution of heat will gain in extent and precision, in proportion as observations shall be more multiplied, and directed to those points which it is of most importance to illustrate.

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* As this interesting and valuable Memoir, the original of which was published in the *Memoires D'Arcueil*, tom. iii. p. 462, has never appeared in our language, and as it must be constantly referred to in all subsequent speculations on Meteorology, and should be familiar to every person who pursues this important study, we have resolved to present a translation of it to our readers. A small part of the memoir appeared in an English journal; but almost all the reductions from the Centigrade to Fahrenheit's scale were so erroneous, that the numbers cannot be trusted. We have added various notes, which will be distinguished from those of the Author by affixing ED. to the former, and H to the latter.—ED.

As the phenomena of geography and of vegetables, and in general the distribution of organised beings, depend on the knowledge of the three co-ordinates of Latitude, Longitude, and Altitude, I have been occupied for many years in the exact valuation of atmospherical temperatures; but I could not reduce my own observations without a constant reference to the works of Cotte and Kirwan, the only ones which contain a great mass of meteorological observations obtained by instruments and methods of very unequal precision. Having inhabited for a long time the most elevated plains of the New Continent, I availed myself of the advantages which they present for examining the temperature of the superincumbent strata of air, not from insulated data, the results of a few excursions to the crater of a volcano, but from the collection of a great number of observations made day after day and month after month in inhabited districts. In Europe, and in all the Old World, the highest points of which the mean temperatures have been determined, are the Convent of Peissenberg in Bavaria, and the Hospice of St Gothard *. The first of these is placed at 3264, and the second at 6808 feet above the level of the sea. In America a great number of good observations have been made at Santa Fe de Begota and at Quito, at altitudes of 8,727 and 9,544 feet. The town of Huancavelica, containing 10,000 inhabitants, and possessing all the resources of modern civilisation, is situated in the Cordilleras of the southern hemi-

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* The mean temperature of the air at the Convent of the Great St Bernard, the height of which is 7,9 [illegible] determined. There are several villages in Europe placed at more [illegible] altitude; for example, St Jacques de Ayas at 5,479, and T [illegible] isfoncy, at 5,315 feet.—H.

sphere at 12,310 feet of absolute elevation; and the mine of Santa Barbara, encircled with fine edifices, and placed a league to the south of Huancavelica, is a place fit for making regular observations, at the height of 14,509 feet, which is double that of the Hospice of St Gothard.

These examples are sufficient to prove how much our knowledge of the higher regions of the atmosphere, and of the physical condition of the world in general, will increase, when the cultivation of the sciences, so long confined to the temperate zone, shall extend beyond the tropics into those vast regions, where the Spanish Americans have already devoted themselves with such zeal to the study of physics and astronomy. In order to compare with the mean heat of temperate climates, the results which M. Bonpland and I obtained in the equinoctial regions from the plains to the height of 19,292 feet, it was necessary to collect a great number of good observations made beyond the parallels of 30° and 35°. I soon perceived how vague such a comparison was, if I selected places under the meridian of the Cordilleras, or with a more eastern longitude, and I therefore undertook to examine the results contained in the most recent works. I endeavoured to find, at every 10° of latitude, but under different meridians, a small number of places whose mean temperature had been precisely ascertained, and through these, as so many fixed points, passed my *isothermal lines* or *lines of equal heat.* I had recourse, in so far as the materials have been made public, to those observations the results of which have been published, and I found, in the course of this easy, but long and monotonous labour, that there are many mean temperatures pointed out in meteorological tables, which, like astronomical positions, have been adopted without examination. Sometimes the results were in direct contradiction to the most recent observations, and sometimes it was impossible to discover from whence they were taken.

Many good observations were rejected, solely because the absolute height of the place where they were made was unknown. This is the case with Asia Minor, Armenia and Persia, and of almost all Asia; and while the equinoctial part alone of the New World presents already more than 500 points, the greater number of which are simple villages and hamlets, determined by barometrical levelling, we are still ignorant of the height of Erzeroum, Bagdad, Aleppo, Teheran, Ispahan, Delhi and Lassa, above the level of the neighbouring seas. Notwithstanding the intimate relation in which we have lately stood with Persia and Candahar, this branch of knowledge has not made any progress in the last fifty years.

We are not authorised, however, on account of the decrease of temperature in the upper regions of the atmosphere, to confound the mean temperatures of places which are not placed on the same level. In the Old World, good observations, which can alone be used for establishing empirical laws, are confined to an extent between the parallels of 30 and 70 degrees of latitude, and the meridians of 30° east longitude, and 20° of west longitude. The extreme points of this region are the island of Madeira, Cairo, and the North Cape. It is a zone which is only a thousand nautical leagues, (1|7th of the circumference of the globe,) from east to west, and which, containing the Basin of the Mediterranean, is the centre of the primitive civilisation of Europe. The extraordinary shape of this part of the world, the interior seas and other circumstances, so necessary for developing the germ of cultivation among nations, have given to Europe a particular climate, very different from that of other regions placed under the same latitude. But as the physical sciences almost always bear the impress of the places where they began to be cultivated, we are accustomed to consider the distribution of heat observed in such a region, as the type of the laws which govern the whole globe. It is thus that, in geology, we have for a long time attempted to refer all volcanic phenomena to those of the volcanoes in Italy. In place of estimating methodically the distribution of heat, such as it exists on the surface of continents and seas, it has been usual to consider as real exceptions every thing which differs from the adopted type, or, by pursuing a method still more dangerous in investigating the laws of nature, to take the mean temperatures for every five degrees of latitude, confounding together places under different meridians. As th [redacted] method appears to exclude the influence of extraneo I first discuss it briefly before I proceed to point essentially different, which I have followed in

The temperature of the atmosphere, and the magnetism of the globe, cannot, like those phenomena which depend on one cause, or on a single centre of action, be disengaged from the influence of disturbing circumstances, by taking the averages of many observations in which these extraneous effects are mutually destroyed. The distribution of heat, as well as the dip and variation of the needle, and the intensity of the terrestrial magnetism, depend, by their nature, on local causes, on the constitution of the soil, and on the particular disposition of the radiating surface of the globe. We must, however, guard against confounding under the name of extraneous and disturbing causes, those on which the most important phenomena, such as the distribution and the more or less rapid developement of organic life, essentially depend. Of what use would it be to have a table of magnetic dips, which, in place of being measured in parallels to the magnetic equator, should be the mean of observations made on the same degrees of terrestrial latitude, but under different meridians? Our object is to ascertain the quantity of heat which every point of the globe annually receives, and, what is of most importance to agriculture, and the good of its inhabitants, the distribution of this quantity of heat over the different parts of the year, and not that which is due to the solar action alone, to its altitude above the horizon, or to the duration of its influence, as measured by the semidiurnal arcs.

Moreover, we shall prove, that the method of means is unfit for ascertaining what belongs exclusively to the sun, (inasmuch as its rays illuminate only one point of the globe,) and what is due both to the sun and to the influence of foreign causes. Among these causes may be enumerated the mixture of the temperatures of different latitudes produced by winds;—the vicinity of seas, which are immense reservoirs of an almost invariable temperature;—the shape, the chemical nature, the colour, the radiating power and evaporation of the soil;—the direction of the chains of mountains, which act either in favouring the play of descending currents, or in affording shelter against particular winds;—the form of lands, their mass and their prolongation towards the poles;—the quantity of snow which covers them in winter, their temperature and their reflection in summer;—and, finally, the fields of ice, which form, as it were, circumpolar continents, variable in their extent, and whose detached parts dragged away by currents modify in a sensible manner the climate of the temperate zone.

In distinguishing, as has long been done, between the *solar* and the *real climate*, we must not forget, that the local and multiplied causes which modify the action of the sun upon a single point of the globe, are themselves but secondary causes, the effects of the motion which the sun produces in the atmosphere, and which are propagated to great distances. If we consider separately (and it will be useful to do this in a discussion purely theoretical) the heat produced by the sun, the earth being supposed at rest and without an atmosphere, and the heat due to other causes regarded as disturbing ones, we shall find that this latter part of the total effect is not entirely foreign to the sun. The influence of small causes will scarcely disappear by taking the mean result of a great number of observations; for this influence is not limited to a single region. By the mobility of the aerial ocean, it is propagated from one continent to another. Every where in the regions near the polar circles, the rigours of the winters are diminished by the admixture of the columns of warm air, which, rising above the torrid zone, are carried towards the poles: Every where in the temperate zone, the frequent west winds modify the climate, by transporting the temperature of one latitude to another*. When we reflect, besides, on the extent of seas, on the form and prolongation of continents, either in the two hemispheres, or to the east and west of the meridians of Canton and of California, we shall perceive, that even if the number of observations on the mean temperature were infinite, the compensation would not take place.

It is, then, from the theory alone that we must expect to determine the distribution of heat over the globe, in so far as it depends on the immediate and instantaneous action of the sun. It does not indicate the degrees of temperature expressed by the dilatation of the mercury in a thermometer, but the ratios between the mean annual heat at the equator, at the parallel of 45°, and under the polar ci [redacted] it determines the ratios between the solstitial and equ different zones. By comparing the results of calculation, not with the mean temperature drawn from observations made under different longitudes, but with that of a single point of the earth's surface, we shall set out with that which is due to the immediate action of the sun, and to the whole of the other influences, whether they are solar or local, or propagated to great distances. This comparison of theory with experience will present a great number of interesting relations.

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* Raymond, *Baromet.* p. 108 and 113.

In the year 1693, previous to the use of comparable thermometers, and to precise ideas of the mean temperature of a place, Halley laid the first foundations of a theory of the heating action of the sun under different latitudes [*]. He proved that these actions might compensate for the effect of the obliquity of the rays. The ratios which he points out, do not express the mean heat of the seasons, but the heat of a summer day at the equator and under the polar circle, which he finds to be as 1.834 to 2.310 [†]. According to Geminus [‡], Polybius among the Greeks had perceived the cause why there should be less heat at the equator than under the tropic. The idea also of a temperate zone, habitable and highly elevated in the midst of the torrid zone, was admitted by Esatosthenes, Polybius, and Strabo.

In two memoirs [§], published at long intervals in 1719 and 1765, Mairan attempted to solve the problems of the solar action, by treating them in a much more extended and general manner. He compared, for the first time, the results of theory with those of observation; and as he found the difference between the heat of summer and winter much less than it ought to be by calculation, he recognised the permanent heat of the globe and the effects of radiation.

Without mistrusting the observations he employed, he conceived the strange theory of central emanations which increase the heat of the atmosphere from the equator to the pole. He supposes that these emanations decrease to the parallel of 74°, where the solar summers attain their maximum, and that they then increase from 74° to the pole. Lambert [¶], with that sagacity which distinguishes all his mathematical researches, has pointed out in his *Pyrometrie* the error of Mairan's theory. He might have added, that this geometer confounds a quantity of heat which a point of the globe receives under the latitude of 60° during the three months of summer, with the maximum to which the inhabitants of these northern regions see their thermometers rising in a clear day. The mean temperatures of the summers, far from decreasing from the pole to the tropics, are under the equator, under the parallel of 45°, and under that of Stockholm, Upsal, or St Petersburg, in the ratio of 81°.86; 69°.8; 61°.16 of Fahrenheit's scale. Reaumur had sent his new thermometers to the torrid zone, to Syria, and to the north. As it was then reckoned sufficient to mark the warmest days, an idea was formed of an *universal summer*, which is the same in all parts of the globe. It had been remarked, and with reason, that the extreme heats are more frequent, and even more powerful, in the temperate zone in high latitudes, than under the torrid zone. Without attending to the mean temperature of months, it was vaguely supposed, that in these northern regions the summers followed the ratio of the thermometrical extremes. This prejudice is still propagated in our own day, though it is well established, that in spite of the length of the days in the north, the mean temperatures of the warmest months at Petersburg, Paris, and the Equator, are 65°.66; 69°.44, and 82°.4. At Cairo, according to the observations of Nouet, the three months of summer are 84°.74, and consequently 19° warmer than at St Petersburg, and 15° warmer than at Paris. The summer heats of Cairo, are almost equal to those I have experienced at Cumana and La Guayra between the tropics.

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[*] *Phil. Trans.* 1693, p. 878.

[†] This should be 2.339.—Ed.

[‡] *Isag. in Aratum*, cap. 13. ; Strabo, *Geogr.* lib. ii. p. 97.

[§] *Mem. de l'Acad.* 1719, p. 133; and 1765, p. 145. and 210.

[¶] *Pyrometric oder Vom Maase des Feuers*, 1779, p. 342.

With regard to the *central emanation* of the system of Mairan, or to the quantity of heat which the earth gives to the ambient air, it is easy to conceive that it cannot act in all seasons. The temperature of the globe at the depths to which we can reach, in general differs little from the mean annual temperature of the atmosphere. Its action is of great importance for the preservation of vegeta[illegible] but it does not become sensible in the air, unless where t[illegible] e globe is not entirely covered with snow, and du[illegible] s, whose mean temperature is below that of the whole year. In the south of France, for example, the radiation of the earth may act upon the atmosphere in the five months which precede the month of April. We speak here of the proper heat of the globe, of that which is invariable at great depths, and not of the radiation of the surface of the globe, which takes place even at the summer solstice, and the nocturnal effects of which have furnished M. Prevost with an approximate measure of the direct action of the sun[*].

Mairan had found, that in the temperate zone the heat of the solar summer is to that of the solar winter as 16 to 1. M. Prevost admits for Geneva 7 to 1. Good observations have given me for the mean temperature of the summers and the winters at Geneva 34°.7; 64°.94; and at St Petersburg 46°.94 and 62°.06. These numbers neither express ratios nor absolute quantities, but thermometrical differences considered as the total effect of the calorific influences; the ratios furnished by theory separate the solar heat from every other indirect effect. Euler was not more successful than Mairan in his theoretical essays on the solar heat. He supposes that the negative sines of the sun's altitude during the night give the measure of the nocturnal cooling, and he obtains the extraordinary result[†], that under the equator the cold at midnight ought to be more rigorous than during winter, under the poles. Fortunately, this great geometer attached but little importance to this result, and to the theory from which it is deduced. The second memoir of Mairan, without adding to the problems which had been attempted since the time of Halley, has at least the advantage of containing some general views on the real distribution of heat in different continents. It is true, that the extreme temperatures are there constantly confounded with the mean temperatures; but previous to the works of Cotte and Kirwan, it was the first attempt to group the facts, and to compare the most distant climates.

Dissatisfied with the route followed by his predecessors, Lambert, in his Treatise on Pyrometry, directed his attention to two very different objects. He investigated analytical expressions for the curves, which express the variation of temperature in a place where it had been observed, and he resumed in its greatest generality the theorem of solar action. He gives formulæ, from which we may find the heat of any day at all latitudes; but being perplexed with the determination of the nocturnal dispersion of the acquired heat, or the subtangents of the nocturnal cooling *, he gives tables of the distribution of heat under different parallels, and in different seasons †, which deviate so much from observation, that it would be very difficult to ascribe these deviations to the heat radiating from the globe, and to disturbing causes. We are struck with the slight difference which the theory indicates between the mean annual temperatures of places situated under the equator and the polar circle, and between the summers of the torrid zone and those of the temperate zone. It cannot be expected, indeed, that analysis is capable of determining the distribution of heat such as it exists on the surface of the globe. Without employing empirical laws, and deducing the data from actual observation, the theory can subject to calculation only a part of the total effect, or that which belongs to the immediate action of the solar rays; but after the recent successful applications of analysis to the phenomena of the radiation of surfaces, the transmission of heat through solid bodies, and the cooling of these bodies in media of variable density, we may still expect to be able to perfect the theory of solar action, and to compute the distribution of the heat received into the exterior crust of our planet.

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[*] *Du Calorique rayonnant*, p. 271. 277. 292. [†] *Comment. Petrop.* tom. ii. p. 98.

In discussing what may be expected from the purely theoretical labours of Geometers, I have not spoken of a celebrated, but very concise Memoir of Mayer, the reformer of the Lunar Tables. This work, written in 1755, was published twenty years afterwards, in his *Opera Inedita* ‡. It is a method, and not a theory: It is an essay essentially different from those we have quoted, and, as its learned author calls it, a determination of the mean heat found empirically by the application of co-efficients furnished by observation. The method of Mayer is analogous to that which Astronomers pursue with so much success, when they correct by small steps the mean place of a planet, by means of the inequalities of its motion: It does not present the result of the solar action disengaged from the influence of foreign circumstances; but, on the contrary, it estimates the temperatures such as they are distributed over the globe, whatever be the cause of that distribution. The mean heat of two places situated under different latitudes being given, we find by a simple equation the temperature of every other parallel [*]. The calculations of Mayer, according to which the temperatures decrease from the equator to the poles, as the squares of the sines of the latitudes, give results sufficiently precise, when the place does not differ much in longitude from that of the regions where the empirical co-efficients have been obtained. But, even in the northern hemisphere, when we apply the formula to places situated 70° or 80° to the east or west of the meridian of Paris, the calculated results no longer agree with observation. The curve which passes through those points whose temperature is 32°, does not coincide with any terrestrial parallel. If, in the Scandinavian Peninsula, we meet with this curve under the 65th or 68th degree of latitude, it descends, on the contrary, in North America, and Eastern Asia, to the parallel of from 53° to 58°. But the direction and the inflexions of this curve of 32° of temperature influences the neighbouring isothermal lines in the same manner as the inflexions of the magnetic equator modify the lines of inclination. To demand what is the mean temperature, or what is the magnetic inclination under a particular degree of latitude, is to propose problems equally indeterminate. Though, even in high latitudes the magnetic and the isothermal lines are not rigorously parallel to the magnetic equator, and to the curve of 32° of temperature; yet it is the distance of any place from this curve which determines the mean temperature, as the inclination of the needle depends on the magnetic latitude.

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* *Pyrometrie*, p. 141. 179.

† *Id.* 318. 339.

‡ *De Variationibus Thermometri accuratius definiendis*, (*Opera inedita*, vol. i. p. 3—10.) M. Daubuisson, in a note inserted in the *Journal de Physique*, tom. lxii. p. 449. has given a formula which accords better with observation than that of Mayer. He admits that the temperature increases from the pole to the equator, as the cosine of [illegible] raised to the power of 2½°; but he judiciously adds, that this f[illegible] only to a zone of the Old World, near the Northern Atlanti[illegible]

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[*] The formula given by Mayer was $T = 24 \cos^2 \text{Lat.}$; or $T = 12 + 12 \cos 2 \text{Lat.}$ for Reaumur's scale; and $T = 84 - 52 \sin^2 \text{Lat.}$, or $T = 58 + 26 \cos 2 \text{Lat.}$ for Fahrenheit's scale. Since the publication of Humboldt's memoir, M. Daubuisson has resumed the subject of the earth's temperature in his *Traité de Geognosie*, tom. i. p. 424. Paris, 1819. He gives the following formula, which is almost the same as that of Mayer, for finding the mean temperature, according to the Centigrade scale, viz. $T = 27^\circ \cos^2 \text{Latitude}$. This formula, which is superior in accuracy to Mayer's, gives all the temperatures in *defect* for latitudes below 42°, and in *excess* for all the higher latitudes, as appears from Daubuisson's table. It is therefore obviously defective. M. Daubuisson, however, considers it as applicable principally between the parallels of 30° and 60° of N. lat. It ought to be remarked, that in the above formula, 27° has been *assumed as the mean temperature* of the equator, in order to make the results agree with observations made in the temperate regions, whereas the mean temperature of the equator, as ascertained by Humboldt, is 27°.5; and if this were used in Daubuisson's formula, it would make the differences still more in excess.—Ed.

These considerations are sufficient to prove, that the empirical formulæ of Mayer require the introduction of a co-efficient, which depends upon the longitude, and consequently on the direction of the isothermal lines and their nodes with the terrestrial parallels. Mayer had no intention of disengaging the results which he obtained from the influence of all disturbing causes: He limited himself to the determination of the effects of altitude above the level of the sea, and those of the seasons, and the length of the day. He wished to point out the way which philosophers ought to pursue in imitating the method of astronomers. His Memoir was written at a time when we did not know the mean temperature of three points on the globe; and the corrections which I propose after tracing the isothermal lines, so far from being incompatible with the method of Mayer, are, on the contrary, among the number of those which this geometer seems to have indistinctly foreseen.

Kirwan, in his work on Climates, and in a learned Meteorological Memoir, inserted in the eighth volume of the Memoirs of the Irish Academy, attempted at first to pursue the method proposed by Mayer, but, richer in observations than his predecessors, he soon perceived, that after long calculations, the results agreed ill with observation *. In order to try a new method, he select [illegible] the vast extent of sea, those places

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* Kirwan's *Estim* [illegible] *of the Globe*, chap. iii.

whose temperature suffered no change but from permanent causes. These were in the part of the great ocean commonly called the Pacific Ocean, from 40° of South to 45° of North latitude, and in the part of the Atlantic Ocean, between the parallels of 45° and 80°, from the coasts of England to the Gulf Stream, the high temperature of which was first determined by Sir Charles Blagden. Kirwan tried to determine for every month the mean temperature of these seas at different degrees of latitude; and these results afforded him terms of comparison with the mean temperatures observed on the solid part of the terrestrial globe. It is easy to conceive, that this method has no other object, but to distinguish in climates that is in the total effect of *calorific influences*, that which is due to the immediate action of the sun on a single point of the globe. Kirwan first considers the earth as uniformly covered with a thick stratum of water, and he then compares the temperatures of this water at different latitudes, with observations, at the surface of continents indented with mountains, and unequally prolonged towards the poles.

This interesting investigation may enable us to appreciate the influence of local causes, and the effect which arises from the position of seas, on account of the unequal capacity of water and earth for absorbing heat. It is even better fitted for this object than the *Method of Means* deduced from a great number of observations made under different meridians; but in the actual state of our physical knowledge, the method proposed by Kirwan cannot be followed. A small number of observations made far from the coasts, in the course of a month, fixes, without doubt, the mean annual temperature of the sea at its surface, and, on account of the slowness with which a great mass of water follows the changes of the temperature of the surrounding air, the extent of variations in the course of a month is smaller in the ocean than in the atmosphere: But it is still greatly to be desired [*], that we should be able to indicate by direct experience, for every parallel, and for every month, the mean temperature of the ocean under the temperate zone. The scheme which Kirwan has formed for the extent of the seas, that ought to form the term of comparison, is founded only in a small degree upon the observations of navigators, and to a great degree on the theory of Mayer. He has also confounded experiments made on the superficial temperature of the ocean with the results of meteorological journals, or the indications of the temperature of the air which rests upon the sea: He has obviously reasoned in a circle, when he modified, either by theoretical suppositions or by observations made on the air upon the coasts of continents, the table of the temperature of the ocean, in order to compare afterwards with these same results, partly hypothetical, those which observation alone furnished in the interior of the earth. After the works of Kirwan, we must notice those of Cotte, which are merely laborious, though useful, compilations, which, however, ought not to be used without much circumspection. A critical spirit has rarely presided over the reduction of the observations, and they are not arranged so as to lead to general results.

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[*] See my *Relation Historique*, tom. i.

In detailing the actual state of our knowledge on the distribution of heat, I have shewn how dangerous it is to confound the results of observation with theoretical deductions. The heat of any point of the globe depends on the obliquity of the sun's rays, and the continuance of their action, on the height of the place, on the internal heat and radiation of the earth in the middle of a medium of variable temperature; and, in short, upon all those causes which are themselves the effects of the rotation of the earth, and the inequal arrangement of continents and seas. Before laying the foundation of a system, we must group the facts, fix the numerical ratios, and, as I have already pointed out, submit the phenomena of heat, as Halley did those of terrestrial magnetism, to empirical laws. In following this method, I have first considered whether the method employed by meteorologists for deducing the mean temperature of the year, the month and the day, is subject to sensible errors. Assured of the accuracy of the numerical averages, I have traced upon a map the isothermal lines, analogous to the magnetic lines of dip and variation. I have considered them at the surface of [illegible] a horizontal plane, and on the declivity of mou[illegible]cal plane. I have examined the increase of temperature from the pole to the equator, which is inequal under different meridians; the distribution of the same quantity of heat over the different seasons, in the same isothermal parallel, and under different latitudes; the curve of perpetual snows, which is not a line of equal heat; the temperature of the interior of the earth, which is a little greater towards the north, and in high mountains, than the mean temperature of the atmosphere under the same parallel; and, lastly, the distribution of heat in the ocean, and the position of those bands, which may be called Bands of the warmest waters. As the limits of this extract will not permit me to enter, in a detailed manner, upon these different discussions, I shall confine myself solely to the principal results.

It was formerly the custom to take the *maximum* and *minimum* of temperature observed in the course of a year, and to consider half the sum as the mean temperature of the whole year. This was done by Maraldi, De la Hire, Muschenbröek, Celsius, and even Mairan, when they wished to compare the very warm year of 1718 with the excessively cold years of 1709 and 1740. De la Hire was struck with the identity between the uniform temperature of the caves of the Observatory of Paris, and the mean of the observed annual extremes. He appears to have been the first who had an idea of the mean quantity of heat which a point of the globe receives; and he adds, "We may regard the air of the caves as the mean state of the climate *." Reaumur followed also the method of a *maximum*, though he confessed that it was incorrect †. He noticed the hours at which it was necessary to make observations; and after 1735, he published in the Memoirs of the Academy the extremes of daily temperature: he even compared the produce of two harvests with the sum of the degrees of heat to which during two consecutive years the crops had been exposed. When he treated, however, of the mean temperature of the month, he contented himself, as Duhamel did thirty years afterwards, with recording three or four thermometrical extremes. In order to have some idea of the errors of this imperfect method, I may state, that even in 1777, the mean temperature of Toulon was estimated by Cotte * at 78°.08, though he afterwards found, by employing the whole mass of observations, that it was not more than 60°.26.

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* *Mem. de l'Acad.* 1719, p. 4.

† *Id.* 1735, p. 559.

In order to diminish the errors of the method of annual extremes, it was perceived, though very late, that it was necessary to subdivide the curve which expresses the variation of temperature. Twenty-four extremes divided among twelve months of the year, give an annual mean more exact than the two extremes of all the observations. The ordinates do not increase uniformly and uninterruptedly up to the maximum of the year, and there are partial inflexions sufficiently regular. The more we subdivide, and the more we know the terms in the series, the more will these terms approximate, and the less error will there be in the supposition of an arithmetical progression, and in that of the equidistance of the different *maxima* and *minima* of temperature. These considerations enable us to appreciate the three methods according to which observations are at present made. 1. Observations are made *three times* a-day, at sunrise and sunset, and at two o'clock in the afternoon. This was done at Geneva during the three years 1796, 1797 and 1798. In the observations, the hour of mid-day was preferred to that of sunset. 2. Observations are made *twice* every day, at the two periods which are supposed to give the maximum and the minimum, namely, at sunrise, and at two o'clock in the afternoon. 3. Observations are made *once* a-day, at an hour which, in different seasons, has been found to represent the mean temperature of the day. It is thus that M. Raymond, by a judicious induction, has proved, that the height of the barometer, at mid-day, gives, in our climates, the mean atmospherical pressure, corrected for the diurnal variation.

In calculating † a great number of observations made between the parallels of 46° and 48°, I have found, that a single observation at sunset, gives a mean temperature which differs only some tenths of a degree from that which is deduced from observations made at sunrise and at two o'clock. The deviations of different months, do not exceed 1°.8, and they are very regularly positive or negative, according to the order of the seasons. M. Arago[*] has examined for seven years the observations of noon. They give for Paris 5°.4 more than the mean temperature of the whole year. Upon high mountains in the temperate zone, the difference is scarcely 1°8[†]. By the application of coefficients, variable according to the latitude and the elevation, we may deduce the true mean temperatures from observations made at any particular period of the day, nearly in the same manner as we can ascertain the latitude of a place from altitudes of the sun, taken out of the meridian.

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* *Mem. de la Soc. Roy* [illegible] 104. † *De la Formule Barom.* p. 213.

If we do not stop at two observations of the maximum and minimum, but add a third observation, we commit an error more or less serious, if we divide simply by three the sum of the observations, without attending to the duration of the partial temperatures, and to the place which the third observation occupies between the last terms of the series[‡]. Experience proves, that the mean temperatures of the year, obtained by two or three observations, do not differ sensibly, if the intermediate observation is sufficiently distant (*four* or *five* hours) from the observation of the *maximum* and *minimum*. Whenever, therefore, we do not take into account the duration of the intermediate temperatures, we should prefer the two observations of the extreme temperature, which is the method most generally adopted. We shall content ourselves with pointing out the errors to which it is liable. In our climates, the two extreme terms do not divide the series of twenty-fours into two equal parts. The maximum is an epoch nearly fixed: the rising of the sun retards or hastens it three hours. As we ought to take into account the duration of the partial temperature, in order to find the quantity of heat divided between the night and the day, we must couple the *maximum* of one day with the *minimum* of the day following, and not be content with taking half the sum of all the *maxima* and *minima* of a month. In the ordinary method, we determine only the mean temperature of the part of the day comprehended between the rising of the sun and two o'clock in the afternoon; and we take it for granted that the mean temperature is the same[*] from two o'clock to sunrise next day. This double error, of want of equi-distance and of the coupling of observations, does not in general produce errors of more than some tenths of degrees, sometimes in excess, and sometimes in defect, since the warm and cold days are mixed[†].

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[*] The mean of the observations at noon at Paris was 56°.84; at Clermont in Auvergne (elevation 1348 feet), 56°.30; at Strasburg (elevation 453 feet), 55°.22. *Bulletin de la Soc. Philom.* 1814, Oct. p. 95.—H.

[†] At the Hospice of St Gothard. *Ephem. Soc. Pal.* 1785, p. 47.

[‡] *Example.*—On the 13th June, at 4^h in the morning, 46°.4; at 2^h in the afternoon, 55°.4; and at 11^h in the evening, 50°, (erroneously 46°.4, or 8° Centig. in the original). In calculating by the duration, we have

50°.9 the mean for 10^h of interval, = 509°.0
52.7 9 = 474.3
48.2 5 = 241.0

The true mean of which is 51°.0. The mean of the three observations, as commonly taken, is 50°.6. If we stop at the two extreme temperatures, we shall have for their half sum 50°.45.—H.

All the calculated results will err in defect, if the 365 ordinates, through which the curve of the year passes, do not express an arithmetical progression, and if the partial irregularities do not sensibly compensate one another. It is only on this supposition that we can judge by the extreme terms of the series, of the sum of the terms, that is, of the partial temperatures. It is very obvious, that near the maximum, the increase ought to be more slow than in other points of the curve, and that this increase in the temperature of the air ought to depend on the sine of the sun's altitude, and on the emission of the radiant heat of the globe.

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[*] *Example.*—At sunrise at 6^h, 50°; at 2 o'clock in the afternoon, 62°.6. At sunset, 51°.8; at 2^h, 66°.2; at sunrise, 50°. The true means will be for the first 24 hours 56°.9, and for the second 59°.0, for we shall have

$$\text{For } 8^h,\ \tfrac{1}{2}(50^\circ.0 + 66^\circ.2) \times 8 = 450^\circ.4 \text{ for } 8^h = 472^\circ.0$$
$$16\quad \tfrac{1}{2}(51^\circ.8 + 62^\circ.6) \times 16 = 915^\circ.2 \text{ for } 16^h = 929^\circ.6$$

The method commonly employed gives $\tfrac{1}{2}(50^\circ + 62^\circ.6) = 56^\circ.3$, and $\tfrac{1}{2}(66^\circ.2 + 51^\circ 8) = 58^\circ.1$. The errors being —0°.6 and + 0.9, sometimes positive and sometimes negative.—H.

[†] The error disa [illegible] s of equal temperature succeed one another. It amounts to 1°.8, i [illegible] ures of two successive days differ from 7° to 9°, which however [illegible] —H.

It appeared to me very important to establish, by observations made at every hour, at different periods of the year, and under different latitudes, the degree of confidence that can be placed in those results which are called *Mean Temperatures.* I have selected from the registers of the Royal Observatory at Paris clear and calm days, which offered at least ten or twelve observations. Under the equator, I have spent whole days in determining the horary increments and decrements of temperature, in marking the thermometer both in the shade and in the sun, and also the progress of evaporation and humidity; and in order to avoid calculation, I measured with a quadrant the altitude of the sun at each observation. I chose days and nights completely calm, and when the heavens were entirely free from clouds, because the mass of vesicular vapours interrupts the radiation from the earth. The result of these experiments has been very satisfactory, and proves, what had already been deduced from the coincidence between the temperature of the earth and the mean of daily observations, and from the regular progress of the mean temperatures of months in different years, that the effects of small disturbing causes may be compensated by a great number of observations[*]. I have obtained analogous results by taking, for several months, the mean of 9 o'clock in the morning, of sunrise and midnight. I have computed the temperatures by the distance of the *maximum* expressed in time, and on the supposition of an arithmetical progression. I have found that, under the Torrid Zone, the morning curve from sunrise to the *maximum*, differs very regularly from the even-

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[*] On the 3d and 4th September 1811, lat. 48°.50′.

Sum of the temperatures during 24 hours.	True mean temperature, taking into account the duration.	Half sum of the two extreme temperatures.
625°.71 Fahr.	57°.92 Fahr.	58°.28 Fahr.
672.49	59.90	61.88
834.67	66.74	65.12
834.67	66.74	68.00
835.37	66.74	63.50
	63.61 Mean.	63.35 Mean.

The three last days shew an equality of temperature, which is very surprising, and which does not appear but in the true means.—H.

ing curve. In the morning the true mean temperature, such as we find by taking the duration into account, is a little greater than half the sum of the extremes[*]. In the evening the error is in a contrary direction, and the series of temperatures approaches more to a progression by quotients. The differences do not in general exceed half a degree, and calculation proves that the compensation is regular. It would be curious to examine the effect which the radiation of the earth has on these horary effects, as the changes of temperature at the surface do not follow the geometrical progression, in so far as they take place in a medium of uniform temperature.

In order to avoid the use of an arbitrary measure, astronomers express the diameters of the planets by taking that of the earth for unity. In like manner, I express the mean temperatures not in parts of the equatorial heat, but by the arithmetical ratios which subsist between this heat and that of the other parallels. This method frees us from the want of uniformity, which arises from the use of different thermometers. Instead of saying that in Europe, under the parallel of 45°, the mean temperature is 13°.4 Centigrade, or 56°.12 of Fahrenheit, we say that it is = 1.0°,487, and in lat. 55° = 1.0°,29. These arithmetical ratios inform us of what is most interesting in the theory of the distribution of heat, that in thermometers whose *zero* is the point of melting ice, the mean temperatures under the latitude of 45° and 55° are, in our regions, the *half* and the *third* nearly of the equatorial temperature, which I suppose to be 81°.5.

(To be continued.)

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[*] *Example.*—Latitude 10°.25′.

		Calculation of a true mean by the duration.	Supposition of an arithmetical progression.
Before the *maximum*,	11th September 1799,	70°.52 Fahr.	69°.44 Fahr.
	14th	69.26	68.00
	18th	71.24	70.34
After the *maximum*,	18th August,	68.72	69.80
	20th	70.16	71.24
	27th	68.72	69.26
Before the *maximum*,	17th August,	69.26	68.00
After the *maximum*,	17th August	65.48	66.02
Total effect,	17th August,	67.37	67.01

H.

Art. II.—*On the Antiseptic Power of the Pyrolignous Acid.* By Mr William Ramsay. Communicated by the Author.

About twelve months ago, it was notified in the newspapers, that the acid formed by the destructive distillation of wood, commonly called the Pyrolignous Acid, has the property of preserving animal substances from putrefaction.

Since this fact was announced, I have tried a variety of experiments on this subject, not only as a matter of curiosity, but also with the view of rendering the acid serviceable in domestic economy, and in particular for the preservation of animal substances used as provisions in the victualling of ships.

The pyrolignous acid, the product of the distillation of wood, is now well known in Britain as an article of commerce, and in its native state is a liquid of a white wine colour, possessing a strong acid slightly astringent taste, combined with an empyreumatic smell. When this acid is allowed to remain in a state of rest for eight or ten days, tar of a black colour subsides, and the acid is then comparatively transparent. To purify it further, it undergoes the process of distillation, by which it is freed from a still greater portion of the tar with which it is combined, and it is thus rendered still more transparent. But though the process of distillation is repeated without end, it will never be freed from the volatile oil with which it is combined, and which is the cause of the empyreuma constantly combined with it.

From the above sketch of the qualities of this acid, it may be perceived that it contains the same properties for the preservation of animal matters from putrefaction that the smoking them by wood does, which is practised at present by the most barbarous nations, and which has been handed down from the remotest ages of antiquity.

In the curing of red herrings in this country, the fish, after being freed from the gut, are partially salted, and then suspended by the eye-holes on rods of wood, in a house constructed for the purpose, on the floor of which fires of wood are lighted, and kept burning night and day with a smothered heat, until it is ascertained that the herrings are fully cured. If red herrings were as fully salted as those which are cured in the common manner for white herrings, the fish would be disagreeable from excess of salt, and would not possess the requisite flavour.

From the experiments to be afterwards narrated, the accounts which we have had from France of the antiseptic powers of the pyrolignous acid are fully entitled to credit, and the person who first applied it as an antiseptic, deserves the gratitude of mankind. These remarks are made, not with the idea that the few experiments afterwards mentioned, are of so much importance as to give full information on this subject, my intention only being to induce those who are interested in the curing of provisions, to try its powerful effects. I shall therefore mention a few experiments in the order in which they were made.

On the 10th of July last, a number of herrings were cleaned in the common manner, and, without being salted, were immersed for three hours in distilled pyrolignous acid, of the specific gravity of 1,012. On withdrawing the fish from the acid, they were considerably softened, and had not the firmness of fish taken from a pickle of common salt. In this state they were hung on a rod to dry in the shade, were frequently examined, and, though the months of July and August were very hot, the herrings had not the slightest sign of putrefaction; on the contrary, the smell was quite wholesome, although joined with the flavour arising from having been steeped in this acid. On broiling one of the herrings, the empyreumatic smell was strongly developed, and the fish were by no means agreeable to those who are not accustomed to this flavour; but after being kept for upwards of six months, they remained in a state of complete preservation. From experiments made since, I find that pyrolignous acid, of the specific gravity of 1,012, is too strong for the immersion of fish for so long a period as three hours, but that simply dipping them in acid of the above strength is sufficient for their preservation, if they are afterwards dried in the shade; and on boiling herrings done in this manner, they were very agreeable to the taste, and had nothing of the disagreeable empyreuma which those had which were steeped for three hours in the acid.

Although it is thus evident that fish may be preserved without the intervention of salt; yet mankind are so accustomed to the habitual use of salt in the preservation of food of almost every species, that my next experiments were made with the view of uniting these antiseptics in the curing of provisions.

A number of very fine haddocks were cleaned, split, and slightly sprinkled with salt for six hours. After being drained, they were dipped for about three seconds in pyrolignous acid, then hung on a spit in the shade for eight days before being used. On being broiled, the fish were of an uncommonly fine flavour, delicately white, and were equal to what are called Finnan Haddocks, which are so much esteemed. As a comparative experiment, I allowed one of the fish to remain twelve hours in the pyrolignous acid; on withdrawing it, it was soft and tender, which showed that the acid had begun to decompose the muscular fibre of the fish. On broiling it, it had the same bad qualities of the herrings which were too long steeped in the acid, and was unpalatable, from the strong empyreuma and acid taste.

Herrings were cured in the same manner, and with the same success, by being first slightly cured with salt, drained, and then immersed in the pyrolignous acid. After being dried in the shade for two months, the quality and flavour were equal to those of any red herring which I ever tasted, and the fish retained the shining and fresh appearance which they have when taken from the sea.

When these experiments were begun in July 1819, the manager at the works in which I am interested, dipped a piece of fresh beef in pyrolignous acid of the specific gravity of 1,012. It was not immersed more than one minute: it is now in my possession, (March 4th 1820), and is as free from taint as on the day when the experiment was made, in July: no salt was here used. He at the same time dipped a piece of beef in pure vinegar, the specific gravity of which was 1,009; he informed me that on the 18th of November last it was perfectly free from taint, when, being broiled, it had a very agreeable sub-acid taste. From the latter circumstance, it appears that vinegar possesses in a certain degree the same antiseptic quality as the pyrolignous acid. Since

I was informed of this circumstance, I have cured some haddocks with pure vinegar; they are entirely free from taint, but when cooked they had an insipid taste, from the want of the slight saline taste to which we are accustomed.

From observing the change which takes place on fish when too long immersed in pyrolignous acid, it appears that the acid, when too strong, acts as a solvent of the fish, as the texture is not only shortened, but fibrous matter was diffused through the liquid, and the bulk of the fish was diminished. But when fish are only dipped in the acid, no diminution of bulk takes place.

My experiments have not been extended farther than those above narrated, but from them we may safely conclude, that the pyrolignous acid possesses high antiseptic powers, and that it may ultimately prove eminently useful in domestic economy.

Whether the pyrolignous, or any of the other vegetable acids, were employed in the art of embalming, cannot now be ascertained; but with the view of observing their effects, I six years ago strewed a haddock with pounded tartarous acid in crystals, and hung it up to dry. It never shewed the least sign of putrefaction, and became nearly as hard as wood; and although exposed to casual moisture, and contact with many kinds of gases, no change took place in its external appearance during the above period.

Although my experiments on the antiseptic power of the pyrolignous acid have been chiefly confined to the preservation of fish, yet, from several trials made with it on beef, I find it has the same power in preserving it sound; and when beef is partially salted, and then steeped for a short time in the pyrolignous acid, after being drained and cooked, it has the same flavour as Hamburgh beef; and I have no doubt, that, with proper modifications, its use may be extended to the preservation of every species of animal food. This will be a very desirable object, particularly in the curing of provisions for sea-stores, as a very small quantity of salt will be necessary for keeping them in a sound state; and the acid with which they are impregnated, may prevent the tenden affections to which seamen are subject in long

From what has now been stated, it is obvious, that this acid possesses high antiseptic powers; and considering it a proper subject of inquiry whether the volatile oil with which it is combined, assisted in the preservation of animal substances, I have since dipped haddocks and fresh beef in pure vinegar, of the specific gravity of 1,009. When fish were allowed to remain in the vinegar for a few minutes, I observed that the muscular fibre was immediately acted on, a partial solution of the fish took place, and the acid became milky. When vinegar of a stronger quality was used, the fish was entirely dissolved, particularly if aided by heat. But both fish and beef which were dipped in vinegar of the specific gravity of 1,009, and which were afterwards dried in a summer heat, now remain perfectly free from taint. On mentioning this to a respectable clergyman who resided in a secluded part of the country, where fresh meat cannot at all times be conveniently procured, he stated to me, that for the two last summers the fresh meat used by his family was regularly wiped with a cloth which was previously moistened with pure vinegar of the specific gravity of 1,034; and that the beef, veal, &c. were thus kept sweet and fresh during the heat of summer, several days longer than they otherwise would have been *.

From the solvent power of pure vinegar, it is obvious, that a new compound is formed by its union with inert animal substances, and it is probable, that, in consequence of this union, they are preserved from putrefaction. When a linen cloth is moistened with vinegar, and fully dried, the vinegar is evaporated, and no trace of it is left on the cloth; but when the same vinegar is applied to animal substances in the manner formerly described, by steeping them in it, they retain the acid taste, although dried in a stove at the temperature of 80 degrees of Fahrenheit's thermometer for eight or ten days.

Fish cured with the smoke of wood, are by no means disagreeable to most people. Now, the immersion of food in the pyrolignous acid, is merely the application of the smoky principle (if it may be so termed) in the liquid state. But whether

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* Vinegar in its pure state, of the above strength, is sold by Mr John Crombie, Merchant Street, Edinburgh, and by J. and A. Millar, Bishopsgate Street, London.

it would be safe to pack fish in bulk which have been immersed in the pyrolignous acid, when caught at a distance from land, must be the subject of experiment by those who are interested in this business. If it is tried, I would advise, that after the fish are well cleaned, they be merely fully dipped into the acid, and then laid on a drainer, so constructed that none of the acid is lost. When fully drained, they may be packed into a cask in the common manner; and when it is perceived that the texture is not injured, a slight sprinkling of salt may be given to them, to render them more palatable. If the fish are in good preservation, it would prevent vessels which remain long at sea in the prosecution of the fishery, from being lumbered with the stowage of salt.

When the pyrolignous acid seems too impure for further use, it may be clarified by the following simple process: A dozen of fresh eggs, after being well beat up in the common manner as used for clarifying liquids, may be added to every twenty gallons of the impure acid, which is to be heated in an iron boiler. Before boiling, the eggs coagulate, and bring the impurity to the surface of the boiler, which must be carefully skimmed off. The acid must then be withdrawn from the boiler, as it is a solvent of iron, which would darken its colour.

It may not be foreign to the present subject, to mention an improvement made by me in the repacking of white herrings, a branch of trade which is now of so much importance to this country.

About six years ago, I was applied to by an extensive dealer for a method of purifying the brine used as a pickle in repacking herrings. He told me, that it had been customary with him to boil the brine, and to skim off what was supposed to be the impurities contained in it, but that it still remained impure as formerly, and continued to retain its putrid smell.

On trial of a portion of the impure brine, I found that this was the case, and that the matter thrown to the surface of the liquid, when boiled, was in reality salt combined with the impurities contained i [redacted] evaporation. The brine with which white herrings are n the casks in which they are packed, is always nce the cause why salt crystallises on the surf as it boils.

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The method which I followed in purifying the brine was simply as follows: It was diluted with water to the specific gravity of 1,160, and then put into a clean cast-iron boiler. For every thirty gallons of English wine measure, a dozen of eggs were beat up and mixed with the brine; at the same time, about half a pound of fine ground charcoal was also put into the boiler, and the whole well stirred together. The brine being now below saturation, when heated, allows the impurity contained in it to rise to the surface, and when brought to boil, is carefully skimmed off. The liquid on cooling is now as pure as water. It is well known that charcoal imbibes putrid effluvia. This substance frees the brine from its offensive smell, and at the same time the eggs coagulating, carry off the charcoal and impurities of the brine entirely to the surface. On again packing the herrings, a very small portion of salt is strewed on them, so that the brine may again become saturated; and the brine, when cooled, is poured into the cask until the fish are covered by it.

The very respectable dealer whom I directed to the above process for clarifying brine, has frequently told me, that, since he adopted it, he has never had a complaint against the herrings; and, as a proof of this, he disposes of several thousand barrels yearly.

GLASGOW, *March* 1820.

ART. III.—*On the Length of the Pendulum, in reply to a Letter contained in* No. XVI. *of the "Quarterly Journal of Science."* By WILLIAM WATTS, Esq.

I FEEL myself called upon to notice certain observations contained in a letter which has appeared in No. XVI. of the "Quarterly Journal of Science, Literature, and the Arts," under the signature of Z, relative to my remarks on Captain Kater's Paper containing Experiments for determining the length of the Seconds Pendulum in the latitude of London; because this critic has thought fit to give a very *partial* and *unfair* outline of my paper; and to misrepresent the facts which it contains.

He commences with observing, that "this writer (a Mr William Watts of the Customhouse, Penzance,) begins by mistaking the length of the Seconds Pendulum for that of the Pendulum of Experiment; and in consequence arrives at the conclusion that the number by which the square of the arc of vibration is to be multiplied is *incorrect.*" In reply to this, I candidly acknowledge that I have committed a small mistake in correcting an error which Captain Kater has fallen into, relative to the correction due to the amplitude of the arc of vibration; and I *now* find that the said error does not amount to more than *one-third* of what is stated in my former paper; as the number by which the square of the arc of vibration is to be multiplied, should have been stated at about 1,6385, instead of 1,645: whereas the factor given by Captain Kater is 1,635; consequently it is *incorrect*, as already asserted, although not to the same degree.

This mistatement, in the magnitude of the error committed by Captain Kater, is of little or no consequence,—first, Because the formula, which he has employed for the purpose of reducing a *finite* circular arc, to the case of an *infinitely small* arc of vibration, is not the *appropriate* one; and, secondly, Because I have *already* furnished the proper formula,—given the demonstration of it, and deduced from it the correct result, due to the amplitude of the arc of vibration. And although the demonstration of this important formula forms a *prominent* feature of my paper, and is no where else to be found *correct;* yet it did not suit the purpose of Z even to notice it in the *outline* of my paper, which, he says, he was *tempted* to give!

The next charge is, that I have "convicted Captain Kater of not having expressed the number of vibrations made by the pendulum in twenty-four hours BEYOND *the nearest hundredth of a vibration.*" This is very true, and I might have stated, *not even* TO *the nearest hundredth of a vibration.* But, perhaps, it may be urged that [illegible] a trifling error, and a matter of no importance; but ho[illegible] be, such was not the opinion of Biot, Mathie[illegible]r they expressed the number of vibrations made in a mean solar day, to the *nearest thousandth of a vibration;* and this is all that I contend for. But not to rest the cause upon mere *unfounded* assertions, as Z has done, let us see how the facts stand; and for this purpose, let us resume the 5th set of Experiments, marked (E), since it appears to be entitled to, *at least,* as much credit as any one of the series, and, I imagine, to more than the *first, third* and *fourth* sets, because of the great irregularity which is found to obtain in the decrease of the arcs of vibration in geometrical progression; so much so, that I should not hesitate to reject them as defective, and insufficient for the purpose for which they were intended. Then the great weight being below, we shall find, by the appropriate formula given in my last paper, the following corrections for the circular arcs of vibration, viz. 2,1648; 1,7534; 1,4156; and 1, 1273: which being added to the corresponding number of vibrations made in 24 hours, less 0″,18; and the mean of the whole being taken, there will result 86058,7703, the number of vibrations performed by the pendulum of experiment in the same time. Captain Kater makes it only 86058,76, which is not true even to the *nearest hundredth* of a vibration. And as the clock gains 0″,18 on mean solar time, it follows, that the pendulum of experiment will perform 86058,9503 vibrations in a mean solar day. The distance between the knife edges being 39,44085 inches at the temperature of 62°, and the mean expansion in parts of this distance, due to a change of temperature of one degree of Fahrenheit's thermometer, being equal to its 0,000009959th part, the distance between the knife edges at the temperature of 69°,3 will be found =39,443717 inches, the length of the experimental pendulum in air, at the altitude of 83 feet above the level of the sea.

To find the length of the seconds pendulum we have the following proportion:

$86400^2 : 8,6058,9503^2 :: \overset{\text{inch.}}{39,443717} : \overset{\text{inch.}}{39,132935}$, the length of the seconds pendulum *in air;* add to this 0,00542 the correction due to the buoyancy of the atmosphere, and we shall have $\overset{\text{inch.}}{39,138355}$, the length of the seconds pendulum *in vacuo,* at 83 feet above the level of the sea.

To reduce this length to what it would have been had the observation been made at the level of the sea, we have the following formula:

$l' = l + \frac{2hl}{a}$, where l' represents the length of the pendulum at the level of the sea, l that of the pendulum at the place of observation, whose height above the level of the sea is h, and a the radius of the earth in the latitude of London: hence we shall have

$$l' = 39{,}138355 + \frac{2 \times 83 \times 39{,}138355}{5280 \times 3954{,}583}$$

$= 39{,}138355 + 0{,}000311 = \overset{\text{inch.}}{39{,}138666}$, the length of the seconds pendulum *in vacuo*, at the level of the sea, and at the temperature of 62° of Fahrenheit's thermometer, as estimated by Sir George Shuckburgh's standard scale; or $\overset{\text{inch.}}{39{,}1372405}$ by General Roy's scale; the latitude of the place of observation being $51^\circ\ 31'\ 8'',4$ North; or $\overset{\text{me.}}{0{,}9940999}$, as estimated in parts of the "metre à bouts;" or $\overset{\text{me.}}{0{,}99410306}$, as estimated in parts of the "metre à traits," as I have found, by Captain Kater's experiments, that it would be unsafe to wager that the "*Metre à bouts*" is *less* than $\overset{\text{inch.}}{39{,}370949}$; or that the "*Metre à traits*" is *greater* than $\overset{\text{inch.}}{39{,}370831}$ of the standard scale.

If we add to 39,138666, the length of the seconds pendulum, determined as above, by means of the 5th set of experiments, the correction 0,00017 proposed by Mr Troughton for the specific gravities of the brass and the deal ends, we shall have Captain Kater's length of the pendulum corrected, $\overset{\text{inch.}}{39{,}138836}$, which differs from the length of the pendulum vibrating seconds, as determined by Mr Whitehurst, and corrected by Mr Troughton, by only 0,000324 parts of an inch *in defect*.

It may be also remarked, that if we reject the 1st, 3d, and 4th sets of experiments, the mean error, or the greatest that is to be feared, will be found equal to 0,000044; and as this error may be either in *excess* or defect, it would be unsafe to hazard a bet, that the length of the seconds pendulum, in the latitude of London, is greater than $\overset{\text{inch.}}{39{,}139006}$, which differs from the length of the said pendulum, as determined by Mr Whitehurst, by only 0,000154 parts of an inch *in defect.*

It is beneath the dignity of philosophical discussion even to notice the observation of Z, respecting an object being seen through a telescope, when it is not in the field of view; because it consists in a mere sophism, which logicians denominate "*ignoratio elenchi*," or mistake of the question, that is, when something else is proved which has no necessary connection with the thing inquired into, and consequently gives no determination to the inquiry, although it may seem, at first sight, to determine the question.

I may, therefore, repeat the question, "Why cannot the disappearance of the disk, (or, in other words, why cannot the instant when the disk disappears,) be noted to a quarter of a second, as readily as to an entire second?" Biot has noted the periods of coincidence to a fraction of a denary second, and, in my opinion, no sufficient reason can be assigned why Captain Kater could not have done so likewise.

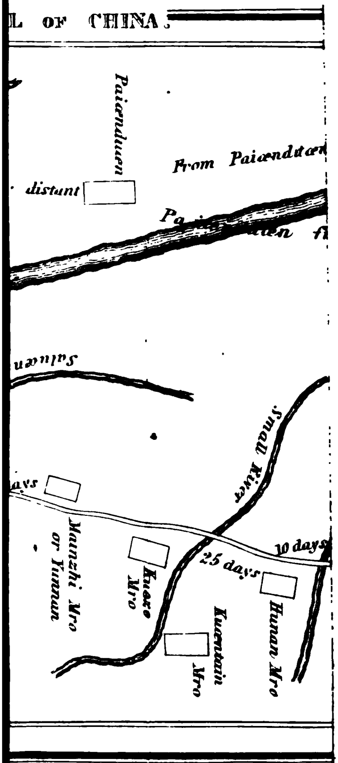
I shall conclude my remarks by observing, that the editor of the Quarterly Journal of Science has thought proper, *in two places of the Index to* No. 16., to apply to my remarks on Captain Kater's experiments, the opprobrious epithet *illiberal;* but with what degree of justice or propriety he has ventured on such an *unwarrantable* interference, with an individual who has given no just ground whatever for reproach, I most cheerfully submit to the decision of the public, only requesting, that it may be kept in view, that the question principally relates to very minute quantities; such, for example, as the 10,000th part of an inch, or to such a degree of accuracy as had not hitherto been attained; for the length of the seconds pendulum had been at least *virtually* determined to about the 10,000th part of an inch long before Captain Kater's attention was directed to the subject; and it was *even* a still greater degree of exactness, as well as verification, of the length of the pendulum vibrating seconds in the latitude of London, which were the objects of his researches.

Customhouse, Penzance,
13*th March* 1820.

ART. IV.—*Account of a Map of the Route between Tartary and Amarapura, by an Ambassador from the Court of Ava to the Emperor of China.* By FRANCIS HAMILTON, M. D. F. R. S. & F. A. S. LOND. & EDIN. Communicated by the Author.

THE map, of which the accompanying is a reduced copy, see Plate I., was given to Captain Symes, the British Resident at Ava, by the Zabua of Bhanmo or Panmo, who had been on an embassy to the court of China, and who repeatedly sent one of his officers to me, in order to explain such matters in the map as occasioned difficulty. This officer accompanied his master on the embassy, where both had acquired a knowledge of the world, and a politeness, that distinguished them much from other Mranma (Burma) chiefs; and the officer at least was acquainted with the Chinese language, having been born on the frontier of the empire, and educated in a town where many Chinese have settled. The map is one of the rudest, which I procured; but is important as tending to settle, by high and perfectly informed authority, many most interesting points respecting the rivers which enter the farther peninsula of India from Thibet and China, and thus enabling us to decide with more confidence on the relative situations of different places in other maps, which contain a greater detail, and are laid down with more skill. It is for this reason that I have given this as a preliminary to maps, in other respects of more merit.

The embassy from the king of Ava received audience of the Chinese monarch a[illegible] called the capital of Taræk, that is of Tartary, mea[illegible] the Emperor's hunting-seat at Gehol. From the[illegible] over a chain of mountains,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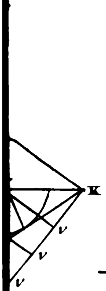
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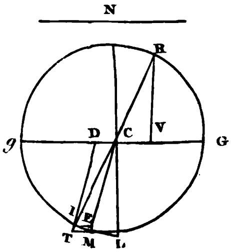
Fig. 7.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having a desert on their right, to Pekin, which the Mranmas call Udin. This journey, which in a straight line, according to D'Anville's map, is about 115 miles, occupied seven days, or rather more than $16\frac{1}{2}$ miles a-day, which would require near 20 miles of road distance. The mountains are those along which the great wall is built, and the desert is that of Shamo, beyond which, on the upper part of the Erawadi, are towns called Khandi and Main Lun, to which I shall have occasion to revert.

From Pekin the embassy returned 10 days journey, to a city called Potisu. From Potisu they returned in wheel-carriages 15 days journey, to a city called Honan, probably the Honan of D'Anville. This being about 420 miles in a direct line from Pekin, and having taken the embassy 25 days, it came $16\frac{8}{10}$ miles of direct distance daily, or very nearly at the same rate as it travelled between the capitals of Tartary and China. The towns mentioned in the map are places where the embassy halted for refreshment.

From Honan to a city called Hupaeh the route was by water, and the journey took a month, probably proceeding down the Hoangho, and up the Yangtse, on account of the immense size of which, the country to the right of the route is marked *water.*

From Hupaeh the route proceeded, by land, 10 days journey, crossing a small river, to a city named Hunan, from whence they returned 25 days journey to a city called Kuezo, which seems to be situated on the right side of the river leading to the city Quentoun, laid down at a distance, as being familiar to Europeans, meaning probably Canton. So far, except for the capitals of Tartary and China, the officer knew only the Chinese names for the cities at which the embassy halted. Towards their own frontier, the Mranmas have names for most of the towns in Yunnan, totally different from those given by the Chinese. The Mranma name for this people the ambassador writes Taroup, and not Tarout, as was done by the slave who gave me the general map; but in both manners of orthography the pronunciation is quite the same, the specific name being always followed by *Pri,* signifying country or capital, and the *T* final is of course sounded as *P*, such being a general habit among the Mranmas.

The 35 days journey from where the embassy landed to the Hongchi or Canton river, at 16½ miles a day, would give a direct distance of 577 miles. This distance from the Canton river, where it enters the province of Yunnan, would place Kuezo, where the embassy disembarked, on the bank of the great lake Tongtinghow. communicating with the Yangtse, up which I suppose the embassy to have come.

The distance between Kuezo and the next city, where the embassy halted, is not mentioned. This city, the residence of a Chinese viceroy, is by the Mranmas called Mainzhi; but the officer sent to explain the map said, that its Chinese name is Yænan, and no doubt it is the Yunnan of our maps. From Yunnan the embassy returned in five days to the town which the Mranmas call Wunzhæn, and the Chinese Yungsænfou. Now four Chinese, who went from Iunnan or Yunnan to Ava, as mentioned in the Universal History, (vol. vii. p. 123.) went first to Iuncham, which, in the Missionaries' or D'Anville's map, according to the compiler, is called Yongchang, and this no doubt is a different orthography for Yungsæn. Although the embassy, according to the map, took only five days to this journey, the Chinese took eighteen, and the distance in a direct line is about 220 miles. It is therefore to be suspected, either that 5 has been placed in the map by the copyist instead of 15, or that in this part of their journey, some particular cause induced the embassy to an extraordinary haste; for the officer said, that the usual route from Yunnan to Tengyechiou passes by Tchouhiong, Tali and Yongchang, between the two last of which alone usually takes seven days. In this part of the route the Kioulong or Mækhaun is crossed in a wooden chest, suspended from iron chains, which are stretched across the river, and drawn backward and forward by ropes.

From Wunzhæn the embassy proceeded five days journey to a town called Momün, which, according to the officer, is the Tænyuensu of the Chinese. Now, the four Chinese already mentioned, from [illegible] our days, went to Tienniotheou, evidently the san [illegible] nyuensu of the ambassador's officer, and with [illegible] of D'Anville, a town about

50 miles from Yongchang. In this journey, the most remarkable thing is, that on the way, the embassy passed the Saluæn river. The officer says, that this the Chinese call Loukiang, and that it falls into the sea at Mouttama or Martaban; but is not near so large as the Erawadi. The river Laukiang in fact is laid down by D'Anville between Yongchang and Tengyechew. The ambassador's map does not mention the Mækhaun river, as it dwells only on a few particulars; but the officer of the ambassador says, that the Chinese call this great river the Kioulong, and that it is of a much longer course than the Saluæn, running round its sources, as he expressed it. Now, in some respects, this agrees with D'Anville's map, the Kioulong-kiang or Mækhaun being in the route between Yunnan and Yongchang, while the Loukiang or Saluæn is between Wunzhæn or Yongchang, and Momün or Tengyechew; but then the Loukiang is made to spring up in Thibet, as far as the Kioulong. I have already mentioned the manner in which the latter river is passed; the great mass of water, with the impetuosity of its current, and roughness of its channel, preventing the use of either a ferry or bridge.

From Momün or Tengyechew the embassy proceeded three days to a city called Mainti, which the officer says is called Nantæntsæn by the Chinese, and they had on their right the small river called by the Mranmas Panmo Khiaun, and by the Chinese Singgai Aho, a name not mentioned in our maps, although it is evidently the river delineated as passing Santa in D'Anville. The officer indeed says, that Tengye is on the bank of this river, while Santa, called Mola Zanda by the Mranmas, is 2 *dain* or 4⅓ miles beyond it, and of course out of the usual route.

With the same river on the right, the embassy came from Mainti to a city by the Mranmas called Mourin, but by the Chinese Launsoen. This is the last town in China, and it must be observed, that in the large map of Yunnan, published with Duhalde, the frontier places towards Ava are called Koen, evidently the same word with the Kaen of the Mranmas, signifying a custom-house. The four Chinese already mentioned were five days in coming from Tienniotheou or Mainti to the last village in Yunnan, which they do not name, but say that it had a garrison and customhouse, and it was probably the same with the Mowun or Launsoen of the embassy. There the Chinese embarked on a river, and in twenty-one days reached Ava. It was probably on the river passing Santa that they embarked, as from Mowun the embassy was three days in reaching Panmo, which is on the bank of the Erawadi, where the river from Santa joins it.

Panmo or Bhanmo, as the slave who composed the general map wrote, is the capital of the principality belonging to the ambassador, and is called Singgai Tsæn by the Chinese. The same people call the Erawadi by the name Kiangnga or Great Fish River, Kiang in the Chinese language implying a great river, and Aho a small one, in the same manner as in the Mranma dialect the former is called Mrit, and the latter Khiaun. Many of these small rivers, however, it must be observed, are larger than the Thames at Windsor. From the circumstances above mentioned, the authors of the Universal History must be wrong in supposing the river of Ava or Erawadi to be the same with the Lu or Loukiang of Yunnan, and the reason assumed for their hypothesis is quite unsatisfactory, for they say, that there is no other river in Yunnan, on that side, so big as the river of Siam, to which the four Chinese compared it; but the fact is, that the four Chinese did not embark until they came to the frontier, and seem only then, as I have said, to have embarked on a branch of the Ava river, at a town three days journey from the great Erawadi, while they must have crossed the Loukiang half-way between Yongchang and Tengye, or seven days journey from where they embarked; and in reality the part of the river Loukiang, between Yongchang and Tengye, according to D'Anville, is about 105 miles in a direct line from the frontier, on the bank of the river passing Santa, where I suppose the Chinese embarked. But, besides, I was assured by the officer, who gave me the account of the map here published, and who, as belonging to Panmo, on the frontier of China, must have been perfectly well informed, that the Erawadi or Ki [illegible] enters the province of Yunnan, but keeps far t [illegible] the whole principality of Panmo being interpose [illegible]

D'Anville, an authority always to be highly respected, considered the Loukiang as the head of the Pegu river, and the Sanpoo of Thibet as the head of the Erawadi; the Brahmaputra having been in a great measure unknown to him. Major Rennell having obtained better information respecting the last-mentioned river, made the Sanpoo and it the same; and although Mr Dalrymple, when he compiled my materials for Captain Symes, still adhered to D'Anville's opinion, I have no doubt that, to a certain degree at least, Major Rennell is in this correct; for among the Hindus of Nepal, the name Brahmaputra is the only one known for what is called Sanpoo in the Chinese survey of Thibet, published by Duhalde, but compiled by D'Anville. In Asam, again, although the term Brahmaputra is known, this great river, or the larger portion of it at least, running towards Bengal, is more commonly called Luhit or Ruhit. While Major Rennell was thus able to correct the error of D'Anville, he was led, perhaps by the Universal History, into a hypothesis equally wrong, supposing the Lu or Loukiang of Yunnan to be the Erawadi, and not to run towards Pegu. It is true, that the river, which passes on the west side of the ancient city of Pegu or Pago, is a stream of very inferior size, and rises in the country of the Mranmas; but the Loukiang of Yunnan, or Saluæn of the Mranmas, runs through the kingdom of Pegu, and falls into the sea at Montama or Martaban, one of its principal cities, and the name Mien, placed by D'Anville in his map of China on the banks of this river, seems no other than Mon, which is the appellation by which the proper natives of Pegu call themselves. By the natives, with whom I conversed, the Saluæn is said to be a rapid and considerable stream, by no means, however, to be compared in magnitude with the Erawadi, which equals the Ganges, Brahmaputra, or other rivers in Asia of the first size.

A little below Ava the Erawadi divides into two branches, each of great size; that passing Ava equalling the Ganges at Banaras, while the other may be compared to the Yamuna at Kalpi. Now, the only two rivers between the Sanpoo and Loukiang, as represented in the Missionaries' Survey of China, published in Duhalde, that could be at all taken for these two branches of the Erawadi, are the Kenpou and that passing

Tchoudsong. The former, which is by far the largest, Major Rennell, our illustrious geographer, conjectured to be the river of Arakan; but I am confident, that in this he was mistaken, for all the native authorities agree in stating, that no great river falls into those salt-water channels, on one of which the city of Arakan stands, and that the largest stream joining these has its source south from the country of Kasi Cassay or Meckley. Mr Arrowsmith, therefore, in compiling the map of Asia, conjectured, with doubt however, the Kempou to be the same with the Khiænduæn, or western branch of the Erawadi, and has thus been reduced to the necessity of representing the river of Tchoudsong as the great or eastern branch of the Erawadi, while the Kenpou and Loukiang, two very inferior streams, have much longer courses; and I have strong reason to suppose, that the Kenpou receives a portion of the Brahmaputra, very much increasing its size, although the greater portion, no doubt, runs through Asam to Bengal. Such anastomoses of great rivers have been doubted by geographers; but the existence of the Casiquiari, connecting the Orinoco and Amazons, seems to be now fully established. I do not, therefore, think the conjecture of Mr Arrowsmith well founded, as it would require the western branch of Erawadi to be larger than the eastern, which is not the case.

On this point two hypotheses may be formed. The one which I adopted, when I delivered the geographical materials to the Governor-General, was as follows. I thought it highly probable, owing to the death of the P. Bonjour, who was employed to survey Yunnan, and the sickness of his companion the P. Fridelli, (Duhalde, folio edition, tome i. preface, p. 35.), and this while they were on the frontier of Ava, that some mistake had crept into the map of the western part of the province of Yunnan, and that the P. Regis, who formed the materials into a map, finding the large river Naukiang coming south in Thibet, and another river running nearly in the same direction through Yunnan, and called Loukiang, took them to be the sa [illegible] any person who is acquainted with the Chinese habi [illegible] N in foreign words into L, would readily forn [illegible]. He therefore, I thought, made the Naukia [illegible] N, take a turn to the eastward, in order to join it to the Loukiang; but I suspected, that he should have continued it straight south, to join the river of Tchoudsong, and that the united streams should have received the river passing Tengye and Santa, as well as that farther south, which the Mranmas call Shue Li. On this hypothesis, the Saluæn or Loukiang would be made to rise from the mountains which separate Yunnan from Thibet, and both the Mækhaun and Erawadi, or Kioulong and Kiangnga, would have much longer courses, as the officer of Panmo asserts is the case. This latter circumstance weighed strongly with me, and I of course conceived the Kenpou to be the same with the Khiænduæn, although I received several accounts, stating that this river proceeded no farther than the country of the Kasi Shan or Nora, which bounds Asam on the south.

Both Mr Dalrymple, however, and Mr Arrowsmith seem to have thought it rash to infer an error in the P. Regis; and, as I am willing to subscribe to their opinion, I have formed another hypothesis, Mr Arrowsmith's, for the reasons above mentioned, being, I think, untenable, as it would make the Khiænduæn larger than the Erawadi. We may suppose that the Kenpou is the principal head of the Erawadi, and, after leaving Thibet, and receiving a branch from the Brahmaputra, which I believe to be the case, that it proceeds south-east to join the river from Tchoudsong in about the 26th degree of N. latitude. Thus, we have two branches of the Erawadi arising from the alpine regions of Thibet covered with perpetual snow, while the Khiænduæn rises from the lower mountains bounding Asam on the south, in about the 25° of N. lat. If this hypothesis be adopted, then D'Anville and Dalrymple are so far right, that a portion of the Sanpoo or Brahmaputra river enters into the Erawadi, and that the Loukiang is not any part of that river, but forms a river of Pegu; although D'Anville is so far wrong, that it is not the river on which the capital of Pegu stands. Major Rennell, again, will be perfectly right in bringing the principal stream of the Sanpoo into Bengal; but wrong in making the Kenpou the river of Arakan, and the Loukiang that of Ava.

To return to the ambassador's map.—At Panmo he was in the capital of his own territory, one of the nine principalities of the Shanmas or Mrelap Shan, as they are called by the Mranmas; but by the Chinese, this people is called Payæ, while Lomüm is the name they give to the Mranmas, or people of Ava. In going from Panmo to Amarapura, to render an account of his mission, the ambassador took fourteen days; so that, the distance being nearly 150 miles in a direct line, he must have come at the rate of eleven miles a day. Zabbæhnago, the Mranma town highest on the Erawadi, is five days of these journeys from Amarapura, and the boundary of the Shanwas may therefore be about sixty miles from the capital, leaving the breadth of the Shanwa territory, between the Mranma boundary on the Erawadi, and Yunnan on the Panmo, above 100 miles. Amarapura is the Pali name for the city called Aenwa zit (New Ava) in the vulgar dialect of the Mranmas, and has been the capital during the late king's reign. In this map, it is called Shueprido, or the Golden Royal Residence, which, among the courtiers of Ava, is a common manner of expression, as is also Mrodogri, or the City of the Great King.

The Shue Li, which in the map is called a Khiaun or small river, has a course of above 200 miles in a direct line, and waters a country of that length, and between 40 and 50 miles wide. About 40 or 50 miles below its mouth, the map places the entrance of another stream, joining the Erawadi on the right, and called the Mæhzha. Some way above the mouth of the Shue Li, this map places, on the same side of the Erawadi with the Mæhzha, another small river called the Kokue, which, in another map, probably by mistake, is called Shue Li; but the two maps hereabout differ a good deal in the relative situations of several towns.

Between the Erawadi and the frontier of Yunnan, and above Panmo, the map places two cities, according to the officer subject to its prince. These are called Kakkio and Wænmo; but we have no rule to judge how far these are from his capital; nor do I find them mentioned in any other map, unless we suppose, that two cities placed in another map in a similar situation, but called by [illegible] names, are the same, the other names having been give[illegible] In this case, the nearest to Panmo would be f[illegible] beyond that city, and the other would be tw[illegible] ther; but this map, giving eighteen days journey from Amarapura to Panmo, a distance of 150 miles, we have 8⅓ miles for each day's journey, making the lower city about 42 miles, and the upper about 58 miles distant from Panmo. The territory of the Prince or Zabua of Panmo, however, occupies the whole space between the Erawadi and Yunnan, probably 230 miles in length, but narrow in proportion.

Opposite to Panmo, and extending along the right bank of the Erawadi, is the territory belonging to the Zabua of Mogaun, the most powerful chief of the Shanwa country. His capital is said in this map to be situated on a small branch of the Erawadi, entering that river opposite to Kakkio, and to be fifteen days journey from Panmo: but Momün or Tengye, by the same calculation, is thirteen days journey, and, being only about 100 miles in a direct line, we have only 7¾ miles for the day's journey, and we must place Mogaun about 15 miles farther from Panmo than Mr Arrowsmith has done. Ten days, or about 77 miles beyond this, between the river of Mogaun and the Erawadi, we have Paiænduæn, a city belonging to the Zabua of Mogaun. Paiænduæn, in another map above mentioned, is made one of the towns situated on the other side of the Erawadi, belonging to the Zabua of Panmo; but as this chief places it in the dominion of his neighbour, there can be little doubt of the author of that map having made a mistake. Beyond Paiænduæn, the Erawadi divides into two branches, the one, I suppose, being the Kenpou, augmented by a branch of the Sanpou or Brahmaputra, and the other being the river of Tchoudsong. Between these, twelve days, or about 90 miles from Paiænduæn, is a town, like it belonging to the Zabua of Mogaun, and called Khandi. It is probable, that Paiænduæn and Kandi are the towns or countries which the people of Asam call Chingpho and Kamti, and place to the west of their country, Chingpho towards the south, and Kamti towards the north. In Mr Arrowsmith's map of Hindustan, the latter has by mistake been placed in the space which should have been occupied by Manipur or Kasi, as will appear from the annexed sketch of Asam, which was drawn by a native, and communicated by me to Mr Arrowsmith. Although I have here stated, that Paiænduæn and Khandi belong to the Chief of Mogaun, yet I have received other information, according to which these towns are governed by distinct chiefs, of the same race, indeed, with the Zabua of Mogaun, but totally independent of his authority, and dignified with the same title. Twenty days journey, or about 150 miles from Paiænduæn, and west from the western branch of the Erawadi, the ambassador's map has a town called Mainlun Wesali, the inhabitants of which, according to the officer, are not subject to Ava, but wear white dresses like the Kulas, or natives of Hindustan, and are, I presume, the people of Asam, who have now adopted the manners of the Bengalese. The officer never was at Mainlun, but learned that the road passes over many difficult mountains. From this account, I do not see it necessary to extend the northern limits of the empire of Ava farther north than has been done by Mr Arrowsmith; but as in his map of Hindustan he has extended Asam a degree farther east than in his map of Asia, the Kenpou, on leaving Thibet, must be bent east, and continued near the frontier till it joins the river from Tchoudsong, when both turn south to Panmo and Ava; and farther, the distance between the frontier of Asam and that of Yunnan in China, in a direct line, will be about 140 miles.

ART. V.—*On the Bed of the German Ocean, or North Sea* *. By ROBERT STEVENSON, Esq. F. R. S. E. & M. W. S. Civil Engineer. Communicated by the Author.

THE efforts of man in exploring the more occult processes of nature are necessarily much circumscribed, especially when his attempts are directed to the investigation of regions which his senses cannot penetrate. It has accordingly been with the utmost difficulty that his exertions have been rendered in any degree successful in prying into the bowels of the earth, or in his endeavours to ascend to the aërial regions. In proof of this, the limited excavations even of the most extensive mining-works, have required the lapse of ages, and the powerful stimulus of commercial enterpri [illegible] ccomplishment. From these, the philosopher has not hitherto derived much light, to enable him to compare the theories which have been assigned by geologists, to account for the various and discordant appearances of the structure of the globe. It has also been with much difficulty, and at no small personal hazard, that the philosophical enquirer has ventured to climb the highest mountains, to examine into the phenomena of the atmosphere. The balloon has indeed enabled us to attain still higher points of elevation; but as yet we do not seem to have made proportional progress in knowledge. In all such attempts to ascend the greatest heights, or penetrate the deepest excavations, we still breathe in our own element, though under different modifications. If, however, we would explore the depths of the Ocean, we immediately encounter an element to which the organization of our lungs is not at all adapted; the density of air, compared with water on a level with the surface of the sea, being in the ratio of 1 to about 850; and our difficulties must consequently increase in a very rapid proportion. Here, therefore, we are unavoidably left to conjecture on many points of our enquiries regarding this highly interesting subject. Even the ingenious contrivance of the Diving-Bell contributes but little towards our investigations for ascertaining the nature of the bottom of the sea, at least to any considerable depth, on account of the difficulty of its application in situations exposed to stormy weather, and also of the increasing ratio of the pressure of the fluid as we descend. This curious machine, it is believed, was invented and employed, about the year 1720, by a Captain Rowe for raising the wreck of ships upon the coast of Scotland; and in the year 1778, the active mind of Smeaton first applied it to the operations of the engineer.

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* Read before the We [illegible] y Society, 25th March 1820.

Our knowledge of the bottom of the ocean, therefore, remains still very imperfect, and, with little exception, the simple apparatus of the mariner, consisting of a plummet and line, continues to be chiefly in use for ascertaining the depth of the sea, and the nature of the ground. With these, and the addition of a little grease applied to the lower extremity of the plummet, which strikes against the bottom, we learn the quality of the soil, though imperfectly, by the particles which adhere to the grease.—What the navigator has yet been able to discover regarding the depth and the nature of the bottom of the German Ocean, I shall now endeavour to notice, being myself enabled to offer the result of a pretty extensive acquaintance with this field of enquiry.

It may be necessary to premise, in treating of a subject so extensive, and in comparing great things with small, that we are obliged to speak of the North Sea as a bay or basin, and of the immense collection of debris which we meet with, extending over a great proportion of its bottom, under the common appellation of Sand-Banks. We must also be allowed to consider the undulating line, or the irregularities of the bottom, to arise chiefly from the accumulation of deposited matters; and in most of the situations connected with these banks, we are supported and borne out in this conclusion, by their local positions relatively to the openings of friths, and the line of their direction in regard to the set or current of the ebb tide.

The accompanying Map (Plate II.) of the eastern coast of Great Britain, with the opposite Continent, though upon a small scale, exhibits numerous soundings of the depth of the German Ocean; and the sections delineated on it will perhaps be found to give a pretty distinct view of the subject. This chart extends from the coast of France, in latitude 50° 57′ to 61° N. On the east, this great basin is bounded by Denmark and Norway, on the west by the British Isles, on the south by Germany, Holland and France, and on the north by the Shetland Islands and the Great Northern or Arctic Ocean. The term *German Ocean*, though in very common use, is certainly not so comprehensive in its application to this great basin as that of *North Sea*, now more generally used by the navigator. The extent of this sea from south to north, between the parallels of latitude quoted above, is 233 leagues, and its greatest breadth from west to east, reckoning from St Abb's-Head, on the coast of Scotland, to Ring Kiobing Froid, on the opposite shore of Denmark, is 135 leagues. The greatest depth of the water in this basin seems to be upon the Norwegian side, where the soundings give 190 fathoms; but the mean depth of the whole may be stated at only about 31 fathoms.

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To be more particular with regard to the depth of the German Ocean, or North Sea, it will be observed by the sections and soundings marked upon the chart, that the water gradually deepens as we sail from south to north. The first of these sections which we shall notice is on the parallel of 3 degrees of east longitude, running from Ostend to the latitude of the northmost of the Shetland Islands, being an extent of 227 leagues. The depth, as will be seen from this section, (which, to avoid confusion in the body of the chart, is traced along the western side of it,) varies rather after an irregular progression, from 120 fathoms towards the northern extremity of this sectional line, to 58, 38, 24 and 18 fathoms, as we proceed southwards, to within five miles of the shore, nearer which we do not approach in our remarks regarding the soundings. Notwithstanding the irregularity of the depth from the occurrence of numerous sand-banks, it is curious to observe the increase upon the whole as we proceed from south to north, by which this sea exhibits all the characteristic features of a great bay, encumbered with numerous sand-banks.

In the same manner, though not strictly connected with our present purpose, we way observe, that the English Channel deepens progressively from Dover to its entrance, formed by the Land's-End of England and the Isle of Ushant, on the coast of France; so that the Strait between Dover and Calais may be said to form a point of partition between two great inclined planes, forming the bottom of these seas.

Besides the longitudinal, or north and south sectional line described above, we have also six other sections delineated in an easterly and westerly direction, across the accompanying chart, which are as follow. One between the Shetland Islands and the coast of Norway; a second between Tarbetness in Ross-shire and the Naze of Norway; a third extends from the Frith of Forth to the coast of Denmark; a fourth from the mouth of the River Tyne to Sylt Island, also in Denmark; a fifth from Flamborough-Head, in Yorkshire, to the mouth of the River Elbe; and the sixth is from Yarmouth to Egmond-op-Zee, on the coast of Holland. Other sections of this sea have also been made, which include the general elevation of the land, as, for example, one of these extends from Holland across the German Ocean to the Thames, and through the interior of the country to the Bristol Channel; then crossing St George's Channel, this sectional line passes through the southern extremity of Ireland and falls into the Atlantic Ocean; but this will be more particularly noticed, when I come to speak of the bed of the English Channel, in a future paper.

On examining the accompanying cross sections, of the depths of water on the same parallel they will be found to vary considerably. It may, however, be stated as a general conclusion, that there is a greater depth of water on the eastern and western sides of the German Ocean than in its central parts, and that, upon the whole, it is deeper on the British than on the continental shores, the coast of Norway excepted.

We have already observed, that this sea is much encumbered with sand-banks, or great accumulations of debris, especially in the middle or central parts, and also along the shores towards what may be termed the apex of the bay, extending from the River Thames along the shores of Holland, &c. to the Baltic. One of these great central banks, delineated on the chart, and known to mariners as the Long Forties, trends north-east in the direction of the ebb-tide from the entrance of the Frith of Forth no less than 110 miles, while the Denmark and Jutland banks may also be traced on the chart from the entrance of the Baltic, upwards of 105 miles in a north-western direction. Besides these, we have also another great central range of banks, which is crossed by no fewer than four of our sectional lines. These are known under the common appellation of the Dogger Bank, which is subdivided by the navigator into the Long-Bank, the White-Bank, and the Well-Bank, including an extent of upwards of 354 miles from north to south. There are also a vast number of shoals and sand-banks, lying wholly to the southward of our section, between Flamborough-Head and Heligoland. Altogether, therefore, the superficies of these extensive banks is found to occupy no in[illegible]rable portion of the whole area of the German Ocean; [illegible] hich, in making these investigations, has been es[illegible] in about 153,709 square miles, while the aggregate superficial contents of the sand-banks alone amount to no less than 27,443 square miles, or include an area of about 5¾ of the whole surface of the North Sea.

But to render these dimensions a little more familiar by comparison, we may notice, that the Island of Great Britain contains about 77,244 square miles, being not quite one-half of the area of the North Sea; so that the area of the Sand-banks bears a proportion equal to about one-third of the whole *terra firma* of England and Scotland; and they are, therefore, perhaps, far more considerable in their extent than has been generally imagined.

In speaking of the dimensions of sand-banks situate in the middle of the ocean, we are aware that great allowance must be made in forming a proper estimate of their extent, especially in speaking of their cubical contents. From a vast number of observations and comparisons relative to this subject, I have, however, been enabled to determine, that the average height of these banks measures about 78 feet, from a mean taken of the whole. In ascertaining their height above the surrounding bottom, the measurement has been taken from the general depth around each respectively. Now, upon taking the aggregate cubical contents of the whole of these immense collections of debris, supposing the mass to be uniformly the same throughout, it is found to amount to no less a quantity than 2,241,248,563,110 of cubic yards, being equal to about 14 feet of the depth of the whole German Ocean, or to a portion of the firm ground of Great Britain, on a level with the sea, taken 28 feet in perpendicular height or depth, supposing the surface to be a level plane.

These calculations at least tend to shew that an immense body of water must be displaced, in consequence of these banks occupying so very considerable a proportion of the bed of the North Sea, the unavoidable effect of which must give a direct tendency to the tidal waters, and the flux produced by storms in the Atlantic, to overflow the bed of the German Ocean, in the same manner as if stones or other matter were thrown into a vessel already nearly brimful of water. This may further be illustrated by considering the actual state of any of the great inland lakes, as those of Geneva, Lochness, Lochlomond, &c.

which for ages past have been receiving the debris of the surrounding mountains. We must doubtless allow that they contain a smaller portion of water, or are actually of a less depth than they were at an earlier period of the history of the globe. Accordingly, from inquiries, which, in the prosecution of this subject, I have been led to make regarding the two last mentioned lakes, it has satisfactorily appeared that their waters are subject to overflow or rise upon their banks. On Lochlomond, in particular, the site of a house at the village of Luss was pointed out to me, which is now permanently under *the summer-water-mark*, while the gable of another house in its neighbourhood is in danger of being washed down by the increase of the waters of the loch. Whether this striking appearance is to be attributed wholly to natural causes, or partly to artificial operations upon the bed of the River Leven, flowing from the loch, I have had no opportunity of inquiring. But the great bench or flat space round the margin of the loch, which is left partly dry during summer, forms altogether such a receptacle for debris, as to be sufficient to affect the surface of the loch, and indeed permanently to raise its waters. We also infer, though by a different process, that the constant deposition going forward in the bed of the German Ocean, must likewise displace its waters, and give them a tendency to enlarge their bed and to overflow their banks or boundary.

In this view of the subject, it will appear that we have not only to account for the supply of an immense quantity of debris, but we must also dispose of the water displaced by the process of deposition which is continually going forward at the bottom of the ocean.

With regard, then, to the supply of the debris of which these banks are composed.—We find that a very great portion of it consists of siliceous matters in the form of sand, varying in size from the finest grains to coarse bulky particles, mixed with coral and pounded shells, the quantity of these calcareous matters being altogether astonishingly great; and being specifically lighter than the particles of sand, the shells generally cover the surface of these sunken banks. With regard to the vast collection of siliceous particles connected with the banks, our surprise ceases when we consider the receptacle which the North

Sea forms, to an almost unlimited extent of drainage from the surrounding countries, on which the change of the seasons, and the succession of rain and of drought upon the surface of the earth, are unceasingly producing their destructive effects. All have remarked the quantity of mud and debris with which every rill and river is charged, even after the gentlest shower; especially wherever the hand of the agriculturist is to be found. His labours in keeping up the fertilizing quality of the ground consist in a great measure in preparing a fresh matrix for the chemical process or the germination of the seeds of the earth, in lieu of that portion of the finely pulverised soil which the rains are perpetually carrying to the sea, as the grand receptacle and store-house of nature for these exuviæ of the globe. From the effect of rills and rivulets, we should, perhaps, rather be apt to expect a greater deposition in the bed of sheltered bays and arms of the sea, than we really observe. So that we can readily believe that the quantity of debris, even for a single year, along such an extent of coast, may bear some consideration in respect to the bed of the German Ocean; what, then, must these effects produce in the lapse of ages?

Whatever be the cause, the fact is certain, that on almost every part of the shores of Great Britain and Ireland, and their connecting islands, from the northernmost of the Shetland to the southernmost of the Scilly Islands, and also upon the shores of Holland, and part of France, particularly in the neighbourhood of Cherbourg, this wasting effect is going forward. These shores I have myself examined. But my inquiries have not been confined to the coasts which I have personally visited, having also, through the kind attentions of some nautical friends, been enabled to extend my investigations even to the remotest parts of the globe. The general result has been, that equally in the most sheltered seas, such as the Baltic and Mediterranean, and on the most exposed points and promontories of the coasts of North and South America, and the West India islands, abundant proofs occur, all tending to shew the general waste of the land by the encroachments of the sea. Such wasting effects are quite familiar to those locally acquainted with particular portions of the shores; and I have often received their testimony to these facts, as the sad experience of the removal of buildings, and the inundation of extensive tracks of land by the encroachment of the sea.

Indeed, by a closer inquiry into this department of the subject, we shall, perhaps, find ourselves rather at a loss to account for the *smallness* of the quantity of this deposition, considering the waste which is constantly going forward in the process of nature, and even be led to seek for its wider distribution over the whole expanse of the bed of the ocean, as has been supposed in that theory of the globe, so beautifully and so ably defended by our late illustrious countryman Professor Playfair.

One of the most striking and general examples of this kind may perhaps be found in the abrupt and precipitous headlands and shores which we every where observe along the coast, and which we suppose to have once been of the same sloping form and declining aspect with the contiguous land. In the production of these effects alone, an immense quantity of debris must have been thrown into the bed of the ocean. The channels which are cut by the sea in the separation of parts of the mainland, and the formation of islands, no doubt make way for a considerable portion of the displaced fluid; but still these channels, when filled with water, come far short, in point of bulk, when compared with the portions of the elevated land which are thus removed. Now, it has been alleged by some, that while the land is wasting at certain points, it is also gaining in others; and this is a state of things which is freely admitted to take place in various quarters; yet these apparent acquisitions are no more to be compared with the waste alluded to, than the drop is to the water of the bucket. But accurate observations regarding the formation of extensive sand-banks, and the accumulation of the debris, of which they are formed, are not to be made in a few years, perhaps not in a century, nor indeed in several centuries; for although the short period of the life of man is sufficient to afford the most incontrovertible proofs of the waste of the land w [illegible] become observers, yet when we extend our views t [illegible] the ocean, and speak of the events and change [illegible] going forward, we must not be supposed to set [illegible]

We have many convincing proofs in the natural history of the globe, that the sea has at one time occupied a much higher elevation than at present. On the banks of the Frith of Forth, near Borrowstounness, for example, I have seen a bed of marine shells, which is several feet in thickness, and has been found to extend about three miles in length, and which is now situate many feet above the present level of the waters of the Forth. A recent illustration of this subject occurred also in the remarkable discovery of the skeleton of a large whale, found in the lands of Airthrey, near Stirling. The present surface of the ground where the remains of this huge animal were deposited, having been ascertained (by my assistants, when lately in that neighbourhood) to be no less than 24 feet 9 inches above the present level of the Frith of Forth at high water of spring-tides. Now, whether we are to consider these as proofs of the higher elevation of the waters of the ocean in the most general acceptation of the word, at a former period, I will not here attempt to enquire. But aside from these anomalous appearances, there is reason for thinking that the waters of the higher parts of the Frith of Forth, like those of the Murray Frith, may at one time have formed a succession of lakes, with distinct barriers, as we find in the case of Lochness, and the other lakes forming the track of the Caledonian Canal. My object on the present occasion, however, is simply to notice the wasting effects of the North Sea upon the surrounding land, its deposition in the bottom of the sea, and the consequent production of surplus waters at the surface, and to endeavour to account for these appearances consistently with the laws of nature. The opinion accordingly which I have formed, and the theory which I have humbly to suggest, (for I am not aware that this subject has been before particularly noticed), is, that the silting up of the great basin of the North Sea, has a direct tendency to cause its waters to overflow their banks.

Referring to the chart, we find that the North Sea is surrounded with land, excepting at two inlets or apertures, the one extending about 100 leagues between the Orkney Islands and the Norwegian coast, and the other between Dover and Calais, which is of the width of 7 leagues. The aggregate *water-way* of these two passages forms the track for the tidal waters, and also for the surplus waters produced during storms which affect the Atlantic and Arctic Oceans. It is also obvious that this water-way must remain nearly the same, and admit a constant quantity; or, to speak more correctly, by allowing these inlets to follow the general law, they must be enlarged by the waste or wearing of their sides, in a ratio perhaps greater than the silting up of the bottom in those particular parts, while the interior and central portions of the German Ocean are continually acquiring additional quantities of debris, along with the drainage water of the widely surrounding countries. If therefore the same, or a greater quantity of tidal and surplus waters continue to be admitted from the Atlantic and Arctic Seas into this great basin, where the process of deposition is constantly going forward, it is evident that the surface of the German Ocean must be elevated in a temporary and proportionate degree, and hence the production of those wasting and destructive effects which are every where observable upon its shores.

This reasoning is also applicable, in a greater or less degree, to all parts of the world; for as the same cause every where exists, the same effects, when narrowly examined, must every where be produced. In the Southern or Pacific Ocean, we have wonderful examples of great masses of land formed by madrepores and extensive coral banks, which in time assume all the characteristic features of islands. These occupy considerable portions of the watery bed of the ocean, and displace corresponding portions of the fluid. Immense quantities of mud are also said to be deposited in the Yellow Sea of China, in the great deltas formed at the mouths of the Ganges, the Plate, the Amazons, the Missisippi, the St Lawrence, the Nile, the Rhine, and other large rivers, whose joint operation both at the surface and bottom of the ocean, are continually carrying forward the same great process of displacing the waters of the ocean; for it matters not to this question whether the debris of the higher country which is carried down by the rains and rivers, or is occasioned by the dir [illegible] ste produced by the ocean itself on the margin of the lan [illegible] at the bottom or surface of the ocean, it must s [illegible] displace an equal or greater bulk of the fluid, and has therefore a direct tendency to produce the derangement which we are here endeavouring to describe.

A striking illustration of this doctrine may be drawn from M. Girard's able and ingenious observations on the delta of Egypt, made in 1799, and published in the *Mem. de l'Acad.* for 1817, in a memoir *Sur la Vallée d'Egypte, et sur l'exhaussement séculaire du Sol qui la recouvre.* It appears that the whole soil of the "Valley of the Nile" is very considerably increased by the alluvium deposited annually by the inundations of the Nile, as ascertained by the marks on some ancient nilometers and statues, the dates of which have been traced and compared by Girard, with the corresponding historical periods. In the quarter of Thebes, where the statue of Memnon is erected, the increase of the soil since the commencement of the Christian era, is $1^{m}.924$ (6 feet 3.7 inches), or this process may be stated as going forward at the rate of $0^{m}.106$ (4.17 inches), in the course of each century. The magnitude of the deposites at the mouths of the Nile in the bed of the Mediterranean appears to be no less surprising. It is remarked, that the Isle of Pharos, which, in the time of Homer, was a day's journey from the coast of Egypt, is now united to the continent.

If, then, we compare these effects with the same process, going forward in a certain proportionate rate over all parts of the globe, and where the same facilities for these depositions being made on firm ground are not afforded, we shall find that the quantity of deposite in the bottom of the ocean must be so considerable as to affect the level of the waters of the ocean.

In thus disposing of the waste of the surrounding land beyond the accumulation of the sunken banks in the German Ocean, we are not left at any loss for a distributing cause, as this is provided by the tides and currents of the sea; and with regard to their action we have many proofs, even at very considerable depths, by the breaking up of the wrecks of ships, the occasional drift of sea-weed, and also drift timber, nuts, &c. into regions far distant from those in which they are spontaneously produced. The dispersion of fishes, evinced by their disappearance from the fishing-grounds in stormy weather, tends to shew the disturbance of the waters of the ocean to the depth of 30 or 40 fathoms. This observation I have frequently had an opportunity of making near the entrance of the Frith of Forth. Numerous proofs of the sea being disturbed to a considerable depth have also occurred since the erection of the Bell Rock Lighthouse, situate upon a sunken rock in the sea, 12 miles off Arbroath, in Forfarshire. Some *drift stones* of large dimensions, measuring upwards of 30 cubic feet, or more than two tons weight, have, during storms, been often thrown upon the rock from the deep water. These large boulder stones are so familiar to the light-keepers at this station, as to be by them termed *travellers.* It is therefore extremely probable, that a large portion of the debris is carried down with the drainage water of the higher country, as before noticed, and ultimately washed out of the North Sea into the expanse of the ocean.

The question which naturally arises as to the result of all this waste or transposition of the solid matters of a large portion of the globe, is to enquire what has become of the body of water displaced by this wasting process. Without attempting to go into all the minutiæ of this part of the subject, I shall here briefly observe, that there seems to exist (if I may be allowed so to express myself) a kind of compensating arrangement between the solid or earthy particles of the globe in the one case, and the waters of the ocean in the other. Thus by the process of evaporation, and the universal application of water, which enters so largely, in its simple or chemical state, into the whole animate and inanimate creation, the surface of the ocean may be kept nearly at a uniform level. Phenomena of this description are, no doubt, difficult in their solution upon the great scale, being met by the process of *decomposition*, which resolves bodies into their constituent parts, and also by our theory of the atmosphere, by which its limits and operations are determined. But were we to abstract our attention from the more general view of the subject, and confine our inquiries to the German Ocean, the Baltic, the Mediterranean, the Red Sea, or to any other inland and circumscribed parts of the ocean, this difficulty seems to be lessened. Indeed the [illegible] bility is, and it is a pretty generally received opinion, [illegible] uantity of water is actually admitted at the Strai[illegible] d of Babelmandel, than flows out of the Medit[illegible] Seas. We consider water, therefore, as the great *pabulum of nature*, which, as before noticed, enters either simply or chemically into the constitution of all bodies, and appears to be held, almost exclusively, in solution, in the formation and maintenance of the whole animal and vegetable kingdoms, and is found to exist largely in the composition of all mineral substances. The quantity of water, consequently, that is required, and is continually supplied from the ocean by the process of evaporation, both for the support and reanimation of nature, must be immense, and may of course be supposed permanently to absorb a very large proportion of the surplus waters of these circumscribed seas, while the remaining portion of surplus water, if not thus wholly accounted for, may be distributed over the general expanse of the ocean.

But if we suppose with some, that in nature there is neither an excess nor diminution of the waters of the globe, and that the united and counterbalancing processes of evaporation, condensation, decomposition, and regeneration, so completely equalize each other, that the surplus waters, arising from the displacement of a portion of the solid surface of the globe, must again be wholly distributed and intermixed with the waters of the ocean, the portion of water remaining thus to be accounted for becomes more considerable, and, upon the great scale, must be permanently disposed of, independently of the process of evaporation.

Another view has been suggested as applicable to the distribution of the surplus waters produced by the gradual filling up of the bed of the ocean. These waters, in place of being elevated in any sensible degree, may be naturally disposed to find their level in the great Polar Basins, or oblate portions of the surface of the globe which are known to exist next the poles. The oblate figure of the earth at the poles makes these imaginary points the nearest to the centre of the earth, and consequently, with regard to level, they are also the lowest. It therefore appears to follow, that any filling up of the bed of the sea near the equator, or at a distance from the poles, will have the effect of promoting the retiring of the surplus waters to the polar regions by their own gravity, while the centrifugal force occasioned by the earth's diurnal motion, will prevent their being farther removed from the earth's centre, without a corresponding elevation of the waters in the great polar basins.

In this manner such an accumulation of water may, at a former period of time, have taken place at the then Poles of the Globe, as to have altered the position of these points, and given rise to the Flood or temporary general overflowing of the waters over the earth's surface, producing a change in the beds of the seas or oceans of former times. In this way may have been produced many of the phenomena observable in the crust of the earth, which are otherwise with much difficulty accounted for.

Of what has now been advanced, regarding the waste of the land by the operations of the sea, it will be proper to notice that much consists with my own personal observation. The consequences of this process must be the deposition of debris, and a tendency to raise the bottom of the ocean, and produce a proportional elevation of the water. With regard, however, to the distribution of the surplus waters that is produced, what I have now said is offered with much deference, in hopes that some one better qualified than myself will turn his attention to this curious subject.

ART. VI.—*Account of Mr Edward Nairne's Process of Artificial Drying and Freezing by the Air-Pump.*

WHEN I observed in the First Number of the *Edinburgh Philosophical Journal*, that your ingenious correspondent Mr Herschel ascribes to Mr Leslie the invention of the process of artificial desiccation by means of *sulphuric acid acting under the receiver of an air-pump*, I had a distinct recollection of having seen the same method in some paper in the *Philosophical Transactions*; but owing to accidental circumstances, it was out of my power till lately to verify this suspicion. The paper to which I allude is written by Mr Edward Nairne, a well known optician, and is entitled "*An account of some experiments made with an air-pump* [redacted] *on's principle*," &c.* It is a paper of very great interest, and, in my humble opinion, contains, not only the method of *artificial desiccation*, but also the principles and almost the whole process of *artificial congelation* by means of evaporation under an exhausted receiver.

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* Published in the [redacted] ns for 1777, vol. lxvii. p. 614.

Having been perplexed by the disagreement of the pear gauge and the common barometrical gauges, in their indications of the degree of exhaustion in the receiver, Mr Nairne was induced to undertake a series of experiments, in order to investigate the cause of the disagreement. He exhibited to the Honourable Mr Cavendish, Mr Smeaton, and other members of the Royal Society of London, an experiment in which this disagreement amounted to some thousand times, and Mr Cavendish immediately furnished him with a satisfactory explanation of the fact. "It appeared," he said, "from some experiments of his father Lord Charles Cavendish, *that water, whenever the pressure of the atmosphere on it is diminished to a certain degree, is immediately turned into vapour*, and is as immediately turned back again into water on restoring the pressure. This degree of pressure is different, according to the heat of the water. When the heat is 72° of Fahrenheit's scale, it turns into vapour as soon as the pressure is no greater than that of three quarters of an inch of quicksilver, or about one-fortieth of the usual pressure of the atmosphere; but when the heat is only 41°, the pressure must be reduced to that of a quarter of an inch of quicksilver before the water turns into vapour. Hence it follows, that when the receiver is exhausted to the above mentioned degree, the moisture adhering to the different parts of the machine will turn into vapour, and supply the place of the air which is continually drawn away by the working of the pump, so that the fluid in the pear gauge, as well as that in the receiver, will consist in good measure of vapour. Now, letting the air into the receiver, all the vapour within the pear gauge will be reduced to water, and only the real air will remain uncondensed; consequently the pear gauge shews only how much real air is left in the receiver, and not how much the pressure or spring of the included fluid is diminished, and that equally, whether it consist of air or vapour."

Now, this ingenious explanation, which Mr Nairne considered as perfectly satisfactory, contains the fundamental principle of producing artificial dryness and cold in the receiver of an air-pump, viz. that the evaporation from any wet body, and consequently its dryness, and the cold arising from evaporation, increase with the degree of exhaustion; and, consequently, that artificial dryness and artificial cold may be produced under the receiver of an air-pump.

In following out the valuable principle of Mr Cavendish, Mr Nairne placed several fluids and wet substances under the receiver. Three grains of water in a watch-glass lost 1½ grains by evaporation in 10 minutes; 100 grains of spirit of wine lost 9 grains. Every substance which he tried sustained a certain loss by evaporation, excepting *sulphuric acid, which always gained*, by absorbing the vapour exhaled from the wet part of the pump. Having thus ascertained that the exhaustion of the air produced a rapid evaporation, and that the sulphuric acid absorbed the vapour thus exhaled, Mr Nairne used this process for producing *dry air in the receiver*, in order to try the effect of the passage of the electric fluid through a dry and a moist atmosphere.

"I now," says he, "put some sulphuric acid into the receiver, as a means of trying to make the *remaining contents of the receiver, when exhausted, as much as possible to consist of permanent air only, unadulterated with vapour*." The consequence of this was, that the electrical phenomena were exhibited in the air which he had dried, and very imperfectly in air which he had made damp, by introducing a piece of wet leather, and removing the sulphuric acid.

The next step which Mr Nairne takes, is to *produce artificial cold by the air-pump*, and he gives an account of his experiment in the following words: "Having lately received from my friend Dr Lind some æther prepared by the ingenious Mr Wolfe, I was very desirous to try whether I could produce any considerable degree of cold by the evaporation of æther under a receiver whilst exhausting. For this purpose, I put the æther into a phial, the neck of which was sufficient to admit the ball of a thermometer: this being placed on the air-pump, under a receiver which had a plate at the top, with a wire passing through a collar of leather; to this wire the thermometer was fixed, by which means I could easily dip the ball of the thermometer into the æther.

"The pump was now worked; and whilst the receiver was exhausting, the ball of the thermometer was often dipped into the æther; and when the degree of exhaustion by the barometer-gauge was 65, (which was the utmost in this case that the pump would exhaust to), the degree of cold indicated by the fall of the quicksilver in the thermometer was 48° below 0° on Fahrenheit's scale; so that there was a degree of cold produced 103° colder than the air in the room where the experiment was made, the thermometer in it being at 55° above 0°. The pump was kept continually working for half an hour, and the ball of the thermometer often dipped into the æther; but no greater degree of exhaustion or cold could be produced. The air being let into the receiver, the quicksilver in the thermometer rose 10°, viz. to 38° below 0°.

"Fresh æther being put into the phial to what was remaining, the thermometer rose to 30° above 0°: the pump was then worked again constantly for half an hour; yet by the barometer-gauge, the degree of exhaustion was now not more than 16°, and the degree of cold produced did not exceed the 11th degree below 0°, as appeared by the quicksilver in the thermometer. The air being let into the receiver, the remaining æther was examined, and there were found several pieces of ice at the bottom of the phial, some of them as big as large peas, which, when the æther became nearly of the heat of 32°, or freezing point of water, were entirely dissolved."

The preceding extracts require no commentary. They establish in the clearest manner the identity of the frigorific processes of Nairne and Leslie; and, as a proof that this opinion is not peculiar to myself, I have much pleasure in stating, what I have learned since the above extracts were made, that an eminent chemist, who has studied this subject most profoundly, has, for some years, in his public course of lectures, felt it to be his duty to ascribe to Mr Nairne the discovery of the processes of artificial drying and freezing by the air-pump.

(Z.)

ART. VII.—*Account of the Flexible Water Main, contrived by the late Mr Watt, for the Glasgow Water-Work Company.* By JOHN ROBISON, Esq. F. R. S. E., &c. in a Letter to Dr BREWSTER.

MY DEAR SIR,

I HAVE now the pleasure of sending you the account which I promised to get for you, of the Flexible Water Main, which the late Mr Watt contrived for the Glasgow Water-Work Company. I am indebted to Mr Creighton for the accompanying drawing. I am, with much esteem, very truly, yours, &c.

JOHN ROBISON.

The Glasgow Water-Work Company derive their supply of water from a well and tunnel formed in a stratum of sand on the left bank of the Clyde, which affords a natural filter for the water of the river. As the city lies on the right bank, the conveyance of the filtered water across the stream was a problem of some difficulty. The fertile genius of Mr Watt, however, enabled him to solve it *.

He suggested that a flexible iron main should be drawn across the bed of the river, through which pumping engines on the north side should raise the water from the well on the south side. In executing this plan, the well and tunnel were dug in the sand near the water's edge. The well is 10 feet in diameter, and its bottom is 12 feet under the ordinary surface of the river; the feeding tunnel is 3 feet wide and 6 feet high, and extends for a considerable distance into the sand-bank: the well has a wooden platform bottom; its sides, and those of the tunnel are built of granite, put together without mortar, and baked with gravel, to prevent the influx of sand. The south end of the section pipe (or main) is turned down into the well to a sufficient depth. That part of it which lies in the bed of the river, is formed of pieces of 9 feet long, (exclusive of joints,)

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* We have heard Mr Watt say, at the time he contrived this water-pipe, that the idea was suggested to him from a consideration of the flexibility of the lobster's tail.—ED.

FLEXIBLE WATER MAIN CONTRIVED BY THE LATE JAMES WATT ESQ.r F.R.S. &c

Fig. 1.

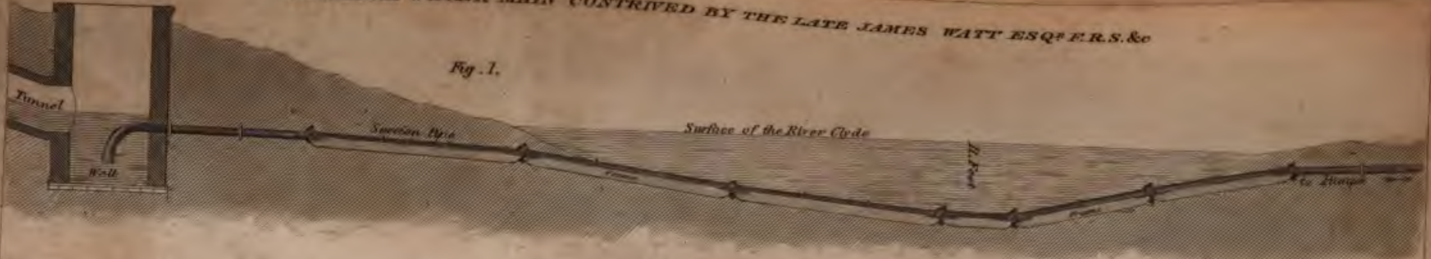


Fig. 2.

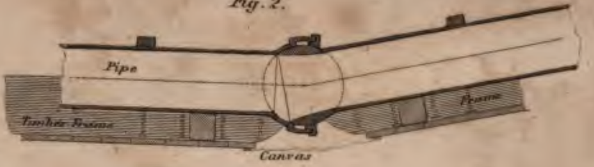


Fig. 3.

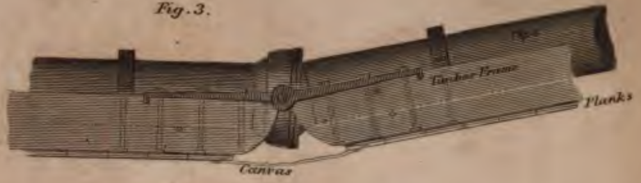


Fig. 4.

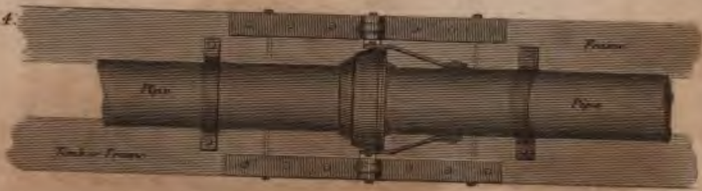


Fig. 5.

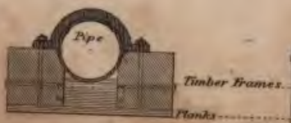
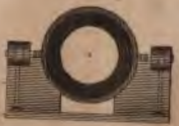


Fig. 6.



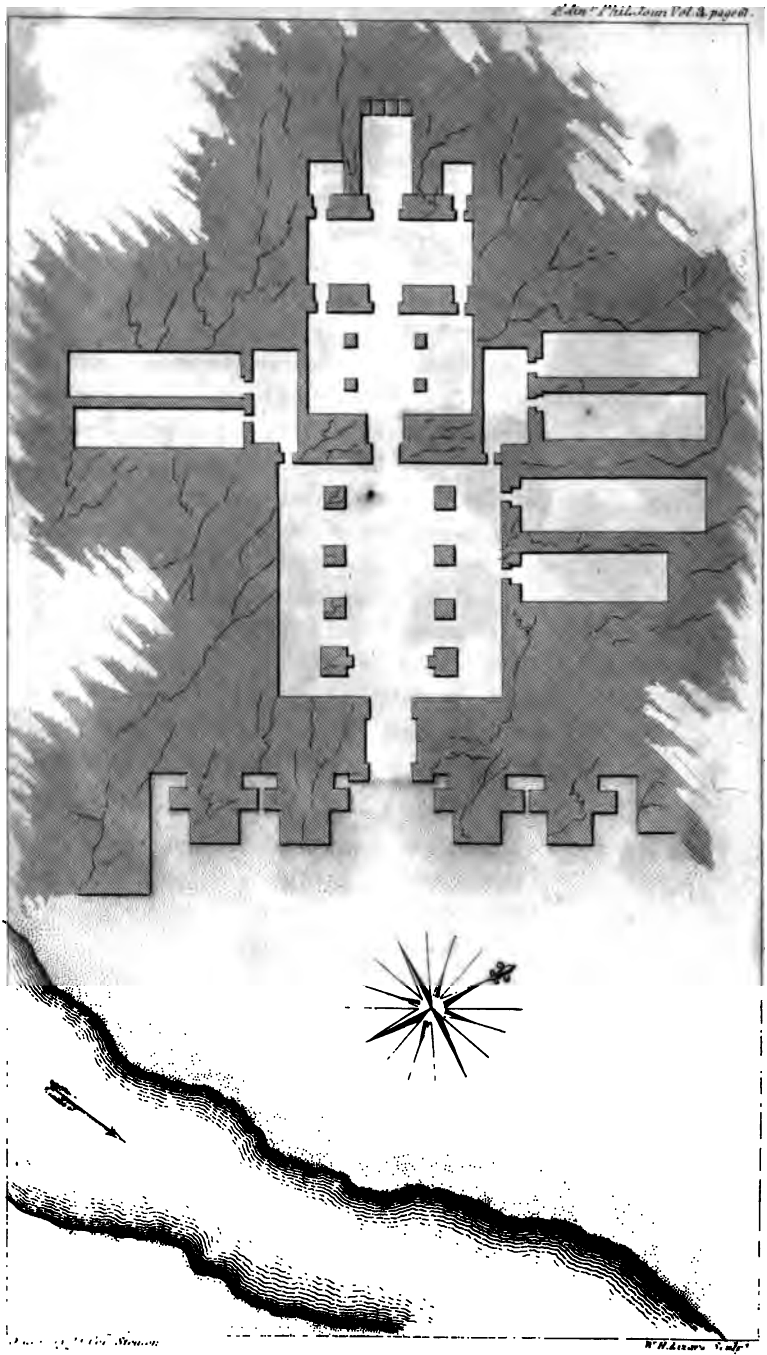
Drawn by H. Creighton Esq.r

W. Archibald Sculp.

Published by A. Constable & C.o Edin.r

PLATE IV.

Edinʳ Phil. Journ Vol. 3. page 81.



[illegible] Stanton

Wᵐ H. Lizars Sculpᵗ

PLAN OF THE TEMPLE OF IPSAMBUL

Edinburgh Published by A. Constable & Cᵒ 1820.

and 15 inches interior diameter. Part of the joints are formed in the usual way, but others are something like what is called "ball and socket," or "universal joints." The whole is laid on strong frames made of parallel logs; these frames are joined by strong iron hinges, having their pivots in horizontal lines at right angles to the axes of the pipes, and passing through the centres of spheres, of which the zones of the sockets are portions. The flexible joints are at the extremities of the frames. This will be easily understood from the figures in Plate IV.

The frames and pipes were put together in succession on the south side of the river, and (the open or north end being plugged,) were hauled into and across the bed, in a trench prepared for them. The machinery for hauling them was of course on the north side; the operation was aided and directed by pontoons, &c. The moveable joints of the pipes, and hinges of the frames, allowed them to assume the form of the bed.

Upon the plugged end emerging from the water on the north side, it was immediately opened and connected with the main leading to the pumps, to secure it against accidents from floods. There is a contrivance for removing any sand which may accumulate in the pipe. That part which is under water is covered over with stones and gravel, to protect it from injury from passing vessels.

Plate III. Fig. 1. is a section giving a general view of the relative situations of the well, and the main through the river leading to the pumps.
Fig. 2. a vertical section through the pipe at one of the flexible joints.
Fig. 3. a corresponding outside view.
Fig. 4. ditto, plan.
Fig. 5. a cross section of the pipe and frame.
Fig. 6. ditto of stock-joint and hinge.

The demand for water having increased beyond expectation since 1810, (when this work was completed,) a second main of 18 inches diameter, similar in all other respects to the first, has been since added.

At present, the consumption of water is reckoned about 8000 tons per diem. The Company's establishment of engines is two of 36 inch cylinders, and 7 feet stroke, and one of 54 inch cylinder, and 8 feet stroke. These are employed in raising the water from the filter to the reservoir for distribution; but as some parts of the city lie 150 feet above the level of the river, there are two smaller engines for forcing water from the general reservoir to a higher one to supply these places.

THE GROVE, *April* 1820.

ART. VIII.—*Account of the Subterranean Temple of Ipsambul.* By LIEUTENANT-COLONEL STRATON. Communicated by the Author.

THE Temple of Ipsambul, (see Plate IV.) is situated on the right bank (going up) of the Nile, which in this part of its course runs from south-west to north-east. The side of the river is here formed by a chain of sandstone rock, and in an interval of this chain, there is a valley of sand, the sides of which are formed by two rocks. These rocks are smoothed each into the façade of a temple. One of these temples is sufficiently known.

The valley runs in a steep ascent, from the river to the desert, until the sand becomes so high, as to be on a level with the summit of the rock on both sides.

The sand drifting downwards towards the river, had entered the temple which we propose to describe, and completely blocked up its entrance to many feet above the architrave, so as to conceal the greater part of the stupendous figures, of which a very considerable portion is now visible. The sand is so fine, that when put in motion, it resembles a fluid. While we were ascending, our footsteps occasioned such a current of it, as to give us reason to apprehend that the entrance to the temple would be again blocked up. We owe the removal of the sand, the uncovering of the façade, and the entrance to the temp [illegible] exertions of Messrs Belzoni and Beechey, employed [illegible] se by the British consul Mr Salt.

The sand is now barred out by palm trunks and large stones, but unless a more effectual defence is provided, there is reason to fear, that the curious traveller will not be long gratified with the sight of a superb monument, which, until August 1817, had remained buried and concealed probably for many ages.

Commencing at the south end of the façade, there is a sloping projection of 30 feet. At 4 feet 7 inches is the arm of the first colossal figure cut out of, and projecting from, the façade, between which and the figure there is a connecting block of 3 feet thick. These figures cannot be styled Alto Relievos; they are in fact Statues; they measure 25 feet 5 inches across the shoulders, and four of them occupy the façade, which measures 127 feet. The left shoulder of the first touches the right shoulder of the second, and so on. The rock is brownish and soft, and easily cut by the chisel. The part out of which the statues are formed is whitish, which adds to the effect. They are beautifully cut, and the proportions, notwithstanding their magnitude, and consequent want of models, are so perfectly just, that no feature predominates, and every part appears small, symmetrical, and graceful.

The statue to the north, or right hand of the portal, is visible to the elbow: that immediately to the left, or south of the door, is somewhat mutilated: the statue beyond it is visible to below the shoulder; while the second to the north is buried to nearly the forehead. The statues have the high mitred cap, with the serpent or good genius on the forehead. The nose, mouth, and chin are of the most delicate proportions. The corners of the mouth, almost approaching a smile, give an expression of mildness, while the other features bear a character of firmness.

The neck and shoulders are admirably formed. The muscles of the chest and abdomen are in the happiest repose; the nipple and navel being visible in front *. The statues are supposed to be naked to the middle, where we perceive a handsome ceinture in zigzag lines, and a dress beneath, striped perpendicularly.

Over the architrave of the portal, is an alto relievo of Osiris Hierax, placed in a niche, and measuring 23 feet 2 inches.

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* Although the statues are visible on the sides only to the elbows, still, from the slope of the sand, they are in front visible below the navel.

He holds in both hands the sacred Tor, or *crux ansata*, and has a crown on his head: under his left hand is a female figure in alto relievo, measuring 5 feet 1 inch; and under the right, a staff, with a fox's head at the top. The deception, arising from the correctness of the proportions, is such, that these figures do not appear one half of their real height.

Two heroes in sculpture, having the bird with expanded wings over them *, present to Osiris, with one hand, a figure resembling a monkey, and hold up the other hand.

On the entablature are sculptured, bulls, geese, hawks, grasshoppers, Anubis's, hieroglyphics, &c. &c. On the summit of the cornice are seated figures of monkeys, or possibly of Typhons, indifferently executed. The cornice bears sculptures of serpents, surmounted by globes. From the cornice to the architrave, the space measures 65 feet: the height of the façade may be 100 feet.

We enter the temple through a small hole made in the sand, under the architrave, part of which has been chipped off to facilitate the entrance, which is much choked up by the sand. The façade, as well as the entrance and interior of the temple, are all cut out of the rock, and the great colossal figures, though projecting so considerably, form a part of the same rock.

The first chamber has eight square pillars resting on pedestals, which do not appear in the plan, but which are merely square projections extending 6 inches or so beyond the pillars. Each of these pillars has on its front a large colossal statue of the same block with the pillar. These statues, which are about 22 feet high, have their arms crossed, holding the crooks and flagellum: they wear the mitred cap, and are, in all respects, well formed; the pupil of the eye is painted black; and also the eye-brow, which, beyond the natural arch, is extended artificially by a straight line in black. They are naked to the ceinture, which is fastened by a clasp; below it is a close-fitting dress, reaching nearly to the knee, bearing an ornament or pouch in front, not unlike that of the present Highlanders of Scotland. These statues are co[redacted] with stucco, painted in rich and variegated colours: Their noses are slightly aquiline; the under lip projects a little; the corners of the mouth express a smile; the chin is finely formed; the eye large and full; the eye-brow well arched; and the face very handsome. The expression is serene and benignant, and they resemble much the Jupiter mansuetus of the Romans. The ceiling is painted in blue and red, having a rich border, with large expanded wings.

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* This bird seems t[redacted]ius of the hero: it invariably accompanies him. We shall [redacted]ıcomitant.

The paintings on the wall represent the hero in his car: he is in the act of discharging an arrow from his bow; his aim is sure; his mien determined; his winged concomitant is above him; he wears a helmeted cap; his face and arms are naked; and he has bracelets, armlets and collar. His dress reaches below his knee: He has a girdle, and the reins are fastened round his body. On the side of the car, which is painted blue, yellow, and red, is a quiver. The horses in the car have their nostrils open. They are rampant, snorting, and covered with rich trappings, and plumes on their heads. They are stallions, with long tails, and their eyes partly covered with blinkers. They have *no* bits, but are restrained by a nose band. The hero is followed by three comparatively small chariots, each containing two persons, one of whom drives, while the other carries a bow, arrows, and a shield covered with a leopard's skin.

The hero, with his people, are in the act of storming a fortress, and the artist has seized the moment of surrender. The fortress consists of two storeys. From the first we see some of the enemy tumbling headlong; others transfixed with darts; others at the base on their knees, with their bodies bent in supplication. One has a dart sticking under his eye; another is pulling one from his head; and many have their hands raised in token of surrender.

In a second row are placed the old men, as being unfit for the first ranks: their countenances are impressed with grief and despair, and their hands are raised. In the upper storey, two men hold out a censer of burning incense, and behind are two females supplicating mercy with extended hands,—but the unerring darts of the hero have already transfixed them.

Under the walls is seen a peasant running away, and casting a scared look behind him. He is endeavouring to drive before him five oxen, who, in scampering off, seem, by their tails flying in the air, to participate in the general panic.

The hero appears transfixing with a spear a prisoner of distinction, trampling others under foot, holding a number by the hair of the head with his left hand, while he prepares to strike off their heads with the right. A mulatto is seen, driving before him a group of prisoners, four of which are black, four tawny, and four white. The features are characteristic of the different climates, and shew that the conquests of the hero had extended over various parts of the globe.

From the different dimensions of the figures, we may infer, that the ancient Egyptians expressed strength and power by comparative size. Thus, the hero is immensely colossal, the chief of the enemy is very large, and the person who conducts the prisoners is large, while the prisoners themselves are pygmies.

On another wall, the hero, grateful for his victories, makes offerings to a male deity painted *black*[*]; and to Isis Lunata he offers incense, in token of his farther gratitude to Osiris Hierax. On the adjoining wall are rejoicings, chariot races, processions, &c. The hero and his people are distinguished from the enemy by the difference of costume, of chariots, of shields, &c. The hero is throughout a portrait, though his dresses are various. Sometimes he has the short warlike dress and helmet, and at other times the long loose robe of ceremony, and high cap.

On another pannel, we observed a chariot fight. The horses appear tumbling and confounded with men. Some horses are struck in the chest, others in the head, writhing in pain,—the *equi exanimes*;—seven chariots on each side, two men and two horses to each. These representations are followed by presentations to Priapus. His type, and every visible part, is painted *black*. The hero is ultimately received among the gods, Osiris, Sothis, Isis Lunata, &c. and this apotheosis is represented both in statuary and in painting.

We may here remark the great perfection attained at this early period in sculpture, statuary, and painting. The figures we have had under review, would not disgrace the chisel of Praxiteles or Apelles, or of Canova in our own days. The painting, as far as colouring, expression, and proportion go, is excellent; but the ancient Egyptians appear to have been totally ignorant of perspective, and were not able to group their figures. On the pillars, are represented offerings to Osiris, Isis, or to the three, that is to Osiris, Isis and Son Horus. The dimensions of the statues on the façade, which I was able to take, are as follows:

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[*] This is the first i[illegible] g the Nile of the deity being represented *black*, and is the only [illegible] rked in the Egyptian and Ethiopian mythology.

	Feet.	In.
Breadth across the shoulders,	25	5
Thickness of ditto,	7	10
Distance from the under-part of the forehead to the chin, inclusive,	6	0
Length of the nose,	2	8
Distance from corner to corner of the mouth,	3	0
The eye was 2 feet 2½ inches by 11½ inches.		
The ear was 3 feet 4½ inches by 1 foot 4 inches.		
Distance from the tip of the ear to the nostril,	6	3
The breadth of the nostrils, including the septum of the nose, inside,	1	9
Across the bridge of the nose,	0	9
Distance from the inner corner of one eye to the inner corner of the other, across the nose,	3	2

ART. IX.—*Observations respecting the Vision of the Humble-Bee and the Honey-Bee.* By Sir GEORGE S. MACKENZIE, Bart. F. R. S. Lond. and Edin., &c. &c. In a Letter to Dr BREWSTER.

MY DEAR SIR,

IT is not long since you were engaged in some researches connected with the structure of the human eye. The vision of insects is a subject which, I should think, might derive some illustration from your researches; and I hope that the facts I am about to mention, may induce you to enter on this almost untrodden field. Happening to observe a number of Humble Bees entering and coming from under the door of a dark out-house, I had the curiosity to examine where they had their nest, and I went in, leaving the door half open. I saw the bees coming from a hole in the floor near the wall, and the instant they arrived at the margin of the light admitted by the door, they took wing, although at the distance of several feet from the spot from which they usually rose into the air. I varied the position of this margin or division between the light and darkness, but this made no difference, the bees in every case beginning their flight as soon as they reached the light. While the door was open, I noticed that the bees which arrived appeared to be completely puzzled by the alteration of the position of the door. Some of them alighted, and wandered about in all directions on the floor, crossing repeatedly the direct path to the nest, but never following it. A very few, by accident apparently, got close to the wall, and reached the nest. Those which chanced to alight near the same part of the door by which they had been accustomed to enter, immediately went through, but from the position of the door, they passed in the direction opposite their nest. As soon as they got within the door, they became as much puzzled as the others. Many flew away, as if to try a new route homewards. As soon as I shut the door, remaining in the inside, the bees on entering turned directly towards the hole in the floor; and none of them going attempted to fly till they reached the light. I was cruel enough to repeat the experiment several times, and each time to keep the homeward-bound labourers in suspense and difficulty for some minutes.

These facts seem to prove that bees, although by some means they rapidly and unerringly traverse the air, cannot discover a track on the ground, when the usual marks are removed. They did not discover it even when they met other bees coming out, a proof that they have no means of communication, but that each insect depends on its own instinct exclusively.

I made an experiment on the hive bee, by lifting the hive, and placing it a few yards, three or four, from the place where it usually stood. I was of course stung for my pains; but I had the satisfaction to see the returning bees pass quite close to the hive where it now stood, and go on to the spot where it had stood when they left it. They seemed not only puzzled but angry, and I was obliged to keep at a respectful distance. When the hive was replaced, those bees that had left it after its first removal, stopped for a little at the place where they had quitted it; but in a few minutes all seemed to be quiet and regular as formerly. I removed another hive in the evening, when none of the inhabitants were abroad, and in the morning there was no resumption of confusion whatever. Yours very sincerely,

G. S. MACKENZIE.

COUL, 26*th April* 1820.

ART. X.—*On vanishing Fractions.* By Mr WILLIAM GALBRAITH. Communicated by the Author.

THE subject of vanishing fractions, ever since the early part of the eighteenth century, has been frequently treated by mathematicians. The idea of these fractions first originated about the year 1702, in a dispute between Varignon and Rolle, relative to the differential calculus. Rolle opposed the legitimacy of the conclusions derived from that calculus, because, in an expression for drawing a tangent to a curve, a quantity was obtained, which had both its numerator and denominator equal to 0, and this he regarded as a result so absurd, as to amount to a proof of the fallacy of the method of solution. John Bernoulli soon afterwards, according to Montucla, attempted to clear up the difficulty; and Saurin, upon a renewal of the dispute, farther shewed that $\frac{0}{0}$, in the case alluded to, had a real value. Still, however, the explanations hitherto given seem to have been rather obscure, as these fractions were also the cause of a violent controversy between Waring and Powell in 1760, when they were candidates for the Mathematical Professorship at Cambridge; Waring maintaining that the value of $\frac{x-x^5}{1-x}$ is equal to 4 when $x=1$, and Powell, or perhaps rather Maseres, who is understood to have conducted the controversy, that it is equal to 0.

So late as the year 1803, in his "Principles of Analytical Calculation," Mr Woodhouse, who certainly ranks among the first of British mathematicians, though he perhaps may admit the accuracy of the conclusions, seems inclined to question the legitimacy of the reasoning by which they are obtained. "The value of $\frac{x^2-a^2}{x-a}$," says he, in the 17th page of the preface, "for instance, $(x=a)$ was thought necessarily to equal $2\,a$, although its obvious value is $\frac{0}{0}$, and it was not perceived that, by the very process of making the value $2\,a$, a certain order was arbitrarily instituted, and an extension of a rule made *." This opinion has been again combated by Dr Charles Hutton, in the last edition (1815) of his Mathematical Dictionary, *art.* Vanishing Fractions. A difficulty therefore still seems to attend this subject, which we shall endeavour to remove by the following artifice.

Let a be a constant quantity, and x a variable, which possesses the property of increasing from 0 till it is equal to a. Also let m and n be any positive whole numbers greater than unity, then may x, some part of a, be denoted by $\frac{a}{n}$, and therefore we have $\frac{a^m-x^m}{a-x}=\frac{a^m-\left(\frac{a}{n}\right)^m}{a-\frac{a}{n}}=\frac{a^m n^m-a^m}{n^m}\times\frac{n}{na-a}=$

$$\frac{a^{m-1}}{n^{m-1}}\times\frac{n^m-1}{n-1}=\frac{a^{m-1}}{n^{m-1}}\times(n^{m-1}+n^{m-2}+n^{m-3}+\ldots 1)\ldots.(A)$$

Now, if, for example, $m=2$, and $n=10$, we shall have, by formula (A) $\frac{a^m-\left(\frac{a}{n}\right)^m}{a-\frac{a}{n}}=\frac{a}{10}\times(10+1)=\frac{11\,a}{10}=\left(1+\frac{1}{10}\right)a.$

If $m=2$, and $n=4$, we get as before $\frac{a}{4}(4+1)=\frac{5\,a}{4}=\left(1+\frac{1}{4}\right)a$. Again, if $m=2$, and $n=2$, we obtain $\frac{a}{2}(2+1)=3\,\frac{a}{2}=\left(1+\frac{1}{2}\right)$ ([illegible] $=2$, and n itself be taken, we get $\frac{(n+1)\,a}{n} = \left(1+\frac{1}{n}\right) a$. Therefore, when $m=2$, we see that as n approaches to unity,

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* See also page 15., [illegible] n Berkeley's Analyst.

$$\frac{a^m - x^m}{a - x} = \frac{a^m - \left(\frac{a}{n}\right)^m}{a - \left(\frac{a}{n}\right)} = \left(1+\frac{1}{n}\right) a,$$

approaches to $(1+1)\,a = 2\,a$ as its *limit.* But when $n=1$, $\frac{a^m - \left(\frac{a}{n}\right)^m}{a - \frac{a}{n}} = \frac{a^m - a^m}{a - a} = \frac{0}{0}$ by subtraction, consequently in this case $\frac{0}{0} = 2\,a$.

In like manner, if $m=3$, then as n approaches to unity, $\frac{a^m - \left(\frac{a}{n}\right)^m}{a - \frac{a}{n}}$ approaches to $3\,a^2$. If $m=4$, then it approaches to $4\,a^3$. And in general taking m itself, we may conclude, that $\frac{a^m - \left(\frac{a}{n}\right)^m}{a - \frac{a}{n}} = \frac{a^m - a^m}{a - a}$, when $n=1$ becomes

$$a^{m-1}\,(1 + 1 + \text{\&c. to } m \text{ terms}) = a^{m-1} \times m \times 1 = m\,a^{m-1}.$$

Hence, the value of $\frac{0}{0}$, which in this and similar cases is merely a symbol, shewing that we have arrived at a limit, is always thus obtained with as much certainty from the binomial function under consideration, if we are not mistaken, though the process appears somewhat inductive, as any proposition in mathematics. If in the expression $m\,a^{m-1}$ we substitute x for a, we have $m\,x^{m-1}$ the general fluxional coefficient of any variable x raised to the power denoted by m.

An unexceptionable method of demonstrating this proposition is the more to be desired, as it forms the basis of Landen's Residual Analysis, perhaps one of the best methods of establishing the principles of that calculus, which he considered equivalent to the Fluxionary or Differential Calculus.

EDINBURGH, *April* 1820.

Art. XI.—*Account of the Strata at the Diamond Mines of Mallivully.* By the late Dr James Anderson of Madras.

The following account of the strata at the diamond mines of Mallivully in the Mustaphanagur Circar, was found among the papers of the late Dr James Anderson of Madras, by his nephew Dr Berry. It had been drawn up for the Asiatic Society, but it appears either never to have been sent to that body, or never to have been published in their Transactions.

So early as the year 1767, Dr Anderson had received specimens of the earth and stones found at different depths in these diamond mines, and having, thirty years afterwards, obtained a still more complete series of specimens, he was struck with the correspondence between the two sets, and drew up the following account of them.

The specimens which he received in 1767 were as follows:

(*a.*) Fine grained white lime, in roundish and sometimes angular lumps, agglutinated with some small pieces of whitish quartz, roundish stones of deep red ochre of iron, and light yellow ochre adhering. It is said that the diamonds are found adhering to this stony mass, and beat off by knocking two pieces of it together.

(*b.*) A tophous stone, consisting of fat yellowish iron-clay, talcky small quartz, and calcareous earth conglutinated.

(*c.*) Whitish fat quartz.

(*d.*) Small stones which have been knocked off as above mentioned, washed by a run of water, and searched for diamonds.

(*e.*) The sandy sediment washed from the foregoing small stones, of a yellowish colour and ochrey appearance.

N. B. The calcareous earth and ochrey part of the sediment, effervesce in the nitrous acid.

The specimens of the different strata of earth and stones of the diamond mines at Mallivully, which Dr Anderson received in 1797, were as follows:

No. 1. Strata three feet from the surface, is porous, of a dirty red colour, intermixed with a few particles of white quartz, and, when washed, consisting of fine sandy particles, with but little intermixture of clay.

No. 2. Strata 6 feet from the surface, is a dirty yellowish clay without mixture, very greedy of water after being dried, in which it breaks down suddenly in flakes, emitting globules of air with a slight noise.

No. 3. Strata 12 feet from the surface, is white calcareous matter in large lumps, interspersed with rounded ironstones, smooth on the surface, some of a metallic colour internally, of different hardness, and some small pieces of quartz covered with yellowish clay.

No. 4. Strata 24 feet from the surface, is small pieces of white calcareous matter, interspersed with worn quartz, tophous ironstone, and whitish fat clay.

No. 5. Strata 30 feet from the surface, where water appears, is fat white clay, falling suddenly in water, after drying, when it becomes yellowish; apparently some admixture of ochre.

No. 6. Strata 36 feet from the surface, where the diamond is found, consists of small heavy worn ironstones of various shades of red, yellow, and metallic colour, approaching the hardness of jasper; some pieces of white calcareous matter, rather harder than chalk, but principally a mixture of soil, consisting of calcareous matter, quartzose sand and yellow ochre.

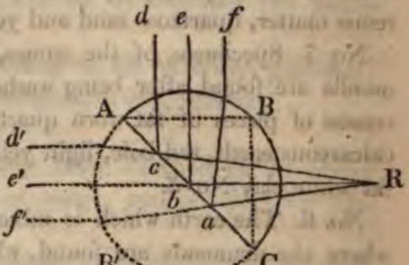
No. 7. Specimens of the stones, &c. amongst which the diamonds are found after being washed from the earth. These consist of pieces of fat worn quartz, tophous ironstone, white calcareous earth, red bole, light yellow ochre, and pieces of the fat white clay No. 5.

No. 8. The earth which is mixed with the stones No. 7. and where the diamonds are found, which differs only from the sediment (*e*) of the former account, in some pieces of the stones No. 6. about the size of peas still remaining in it.

Art. XII.—*Account of some Single Microscopes upon a new construction.* By David Brewster, LL. D. F. R. S. Lond. and Sec. R. S. Edin.

THERE are few instruments which have remained so long unimproved as the common single microscope. During the last 200 years, it has undergone almost no change, and it can scarcely be doubted that the magnifying lenses employed by Leeuenhoek were equal to any that are used in the present day, although our artists may fit them up with more elegance;—and by nicer apparatus, and superior modes of adjustment, may accommodate them better to the purposes of scientific discovery. Any contribution, therefore, to the improvement of the single microscope, however small be its amount, will not be altogether unprofitable, if it has no other effect than to shew that the instrument is still susceptible of interesting modifications, and that the attention of ingenious individuals may be directed to its improvement with some hopes of success.

In the annexed diagram, I have represented *a method of using a plano-convex lens, so as to obtain from it twice the magnifying power which it possesses when used in the common way.*



If ABC be a hemispherical plano-convex lens of half an inch radius, it will magnify about fourteen times as a single microscope; the distance at which the eye sees minute objects most distinctly, being taken at 7 inches. Let us now suppose that the lens is placed, as in the figure, with a microscopic object at R, and the eye at *e*, the rays issuing from the object R, will, after refraction at the surface BC, fall upon the plain side AC, from which they will be reflected at the points *a*, *b*, *c*; and after a second refraction at the surf will emerge parallel to one another at *d*, *e* and *f*, ect R be placed as far before BC as the anterior le convex lens of the same curvature as BC.

As the incidence of the rays upon AC is very little different from 45° when ABC is a hemisphere, and when the apertures are small, they will always be reflected at a greater angle than that at which total reflexion takes place [*], and therefore no light will be lost at the reflecting surface. It is obvious, therefore, that by this method of using the lens ABC, we have produced the same effect as if we had added another hemispherical lens like AB′C, or employed the whole sphere ABCB′, from which the rays would have emerged at d', e', f' after refraction, in the very same manner as at d, e, f after reflexion. As it is impossible to grind a spherical glass sufficiently accurate for optical purposes, the *Reflecting* or *Catoptric Lens* ABC should be compared with a double convex lens, equal to the plano-convex lenses AB and BC put together. Now, in constructing such a lens, we are liable to the error arising from bad centering, in consequence of the two convex surfaces being ground and polished in succession; but in the reflecting lens this source of error is entirely removed, because the two refracting surfaces, AB and BC, are ground simultaneously in the same tool.

As the corners at A and C are not necessary to the operation of the lens, a complete hemispherical surface of 180° will not be required. An arch from 120° to 140° will be sufficient for every purpose, and hence it will be easy to employ the periscopic principle, which we shall presently have occasion to describe. We have only to remove the polish from an annular space of the polished surface AC, having Ac or Ca for its breadth, in order to exclude the lateral or obliquely incident rays.

The reflecting lens ABC may be considered as composed of a right-angled prism ABC, and of two plano-convex lenses, AB and BC, and will therefore form a *new diagonal eye-piece, of the most perfect construction.* Opticians have frequently ground one face of the rectangular prism into a convex surface; but, in so far as I can learn, they have never attempted to form the whole eye-piece out of a hemispherical lens. The simplicity of this construction is very remarkable, as we obtain a better effect, from a *single hemispherical lens with one convex and one plane surface*, than we do from a *prism and two plano-convex lenses, having five plane surfaces and two convex ones*.

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[*] The sine of the angle of total reflexion being equal to $\frac{1}{\text{index of refraction,}}$ will be about 41° in crown glass.

The ingenious idea of Dr Wollaston to render single microscopes periscopic, or to extend their limits of distinct vision, by placing a circular aperture between two plano-convex lenses, as shewn at *m n* in Fig. 1. of the annexed diagram, has suggested several improvements on the single microscope.

Fig. 1.

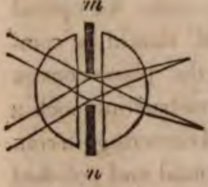


Fig. 2.

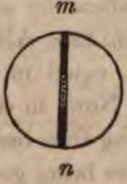


Fig. 3.

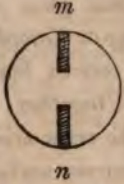


Fig. 4

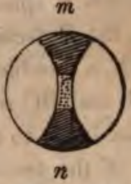
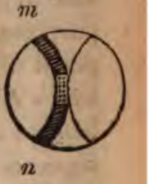


Fig. 5.



Dr Wollaston has himself remarked, " that a portion of light is lost by doubling the number of surfaces; but that this is more than compensated by the greater aperture, which, under these circumstances, is compatible with distinct vision *." In order to remedy this evil, we propose to combine the lenses, as in Fig. 2. where the aperture contains a fluid of nearly the same refractive power as the glass, namely, oil of turpentine, castor oil, or Canada balsam, which will also act as a cement, in holding the lenses in their place.

The same effect may be produced more perfectly in a sphere, or in a very deep double convex lens, by grinding a groove in its circumference, as in Fig. 3. which could be easily done by the wheel of a seal-engraver. In this way the doubling of the surface is avoided, and those sources of error removed which arise from the imperfect centering of four surfaces, and the combination of the two lenses.

If we wish to diminish the aberration of colour, the two lenses used in Fig. 1. and 2. may be double convex ones, and having their anterior surfaces of such radii, as to form a concave lens in the aperture when it is filled with a fluid of a different refractive and dispersive power from the glass. This com-

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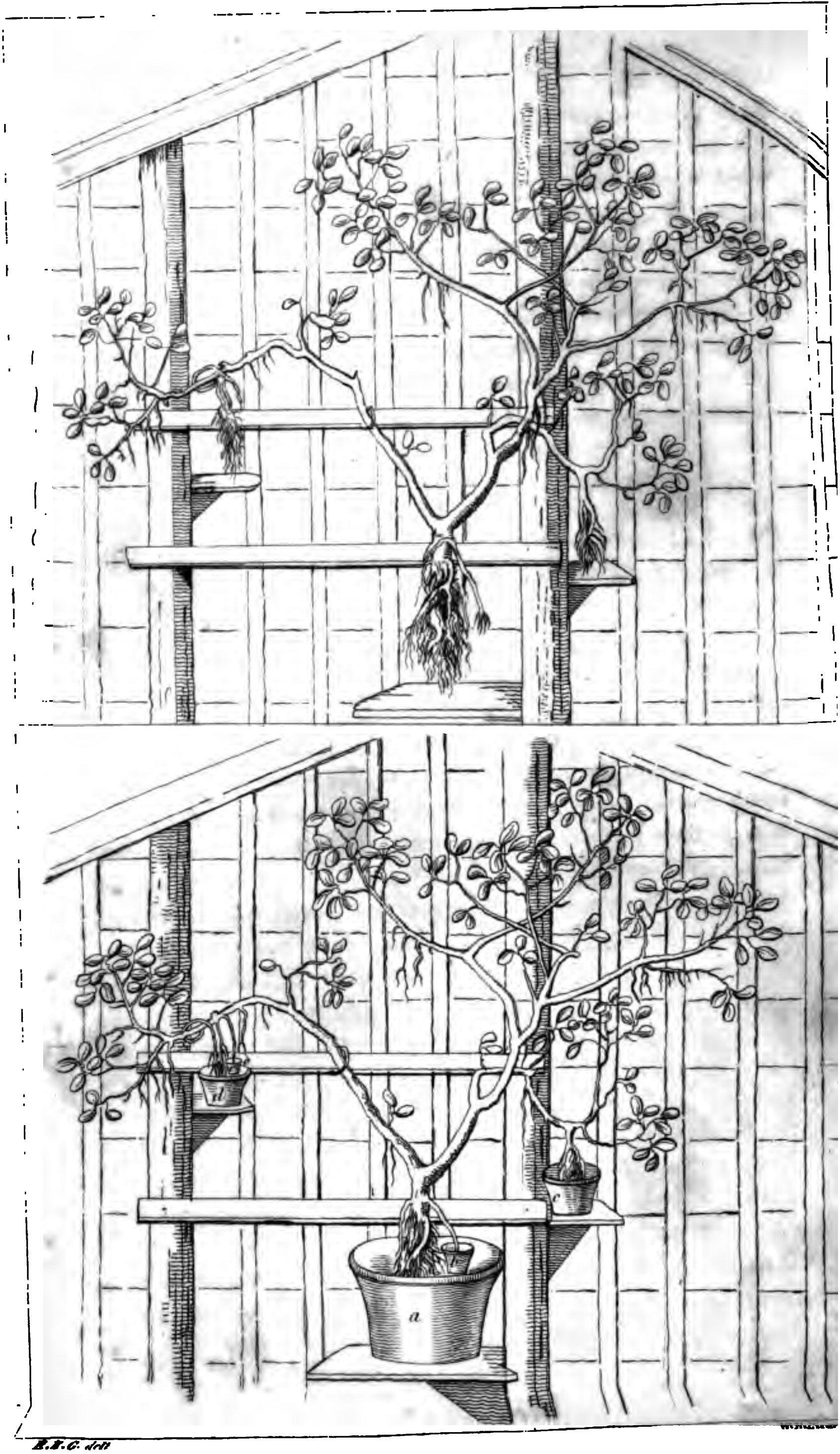
* *Phil. Trans.* 1812, p. 376.

Edinr Phil. Jour. Vol 3. Page 77.



E.B.C. delt

Edinburgh Published by A. Constable & Co 1820.

bination is shewn in Fig. 4., where *m n* is the piece of metal in which the aperture is made.

When the lenses have the size shewn in the diagrams, it would be advisable to place the aperture in the centre of a mirror, *mn*, Fig. 5. made of such a convexity as to reflect upon the object those converging rays which pass through the first lens.

By these means we may communicate the periscopic principle to single microscopes, at the same time that we remedy the loss of light occasioned by the doubling of the surfaces, or correct the aberration arising from the different refrangibility of light.

EDINBURGH, *May* 1820.

ART. XIII.—*Some account of a suspended Plant of Ficus Australis, which has grown for eight months without earth in the Stove of the Botanic Garden at Edinburgh.* By Mr WILLIAM MACNAB, Superintendant of the Garden, Communicated by the Author.

FICUS Australis is a native of New South Wales, and was introduced into the British gardens in 1789, by the Right Honourable Sir Joseph Banks. The plant is not uncommon now in collections in this country, where it has been usually treated as a greenhouse plant; and in a good greenhouse it thrives tolerably well, although it seems rather more impatient of cold than many of the plants from the same country.

When I came to superintend this garden in 1810, I found a specimen of it among the greenhouse plants, where it remained for some time afterwards; but owing to the bad construction of the greenhouse here, and the very hardy way in which I was obliged to treat the plants in that department, I did not find the Ficus thrive so well as I had been accustomed to see it do. I concluded that it required more heat, and in the spring of 1811 I placed it in the stove, where it soon began to grow as vigorously as I had ever seen it do.

After it had been in the stove for some time, I observed a root set out of the stem, about a foot above the earth of the pot in which it was planted. I may observe, that this tendency to set forth roots is no uncommon circumstance with many of the tropical figs; the banyan-tree (Ficus indica), is very remarkable in this respect, in its native country, and some of them in our stoves shew the same disposition. As soon as the root had extended downwards about eight inches, I placed a pot of earth, *b*, (Plate V.) under it, and it soon took hold of the earth and filled the pot with fibres, like those belonging to the original root of the plant. In this state I allowed matters to remain for about a year, when the root from the stem had increased to nearly half an inch in diameter. In the spring of 1814, I cut off the exposed root close to the stem from whence it had issued, principally with the view of observing whether it would put out leaves and branches, and thus be converted into the stem of a new plant. This conversion of root into stem, can be effected in many plants: it failed, however, in the case of the Ficus; for although the whole remained perfectly fresh for a considerable time, no buds or leaves were ever produced.

The original plant soon put out more roots from the stem, which is about a foot in height, before any branches set out; on one of the branches, above two feet from the junction with the stem, a root was also put out. As soon as this last had grown about a foot long, I placed a pot under it, in the same way as I had formerly done. As soon as I found the pot filled with roots, I determined to try whether this pot, *c*, if supplied plentifully with water, would support the whole plant.

In August 1816, I left off watering the original large pot, *a*, and supplied the other, *c*, very freely with water. I kept it in this state for about eight months, till the earth in the large pot was so completely dry, that I was satisfied the plant could receive no nourishment from it. The shrub continued quite as healthy and vigorous as when supplied with water at the original root. In the spring of 1817, I took off the pot *a*, in which the original roots were, and exposed the roots to the full rays of the sun, by gradually shaking off the dry earth from among them; this had no ill effect on the plant, as it still remained perfectly healthy; [redacted] ever had the effect of making roots be put out freely all c much more so than had hitherto been the case.

In the latter end of the summer of 1817, I placed a root in a pot *d*, which was put out from a branch about three feet from the junction with the stem, and on the opposite side of the plant from that which had supported it for some time past. As soon as I found this pot filled with fibres, I supplied it freely with water, and kept the other pot *c* dry, as I had done before with the original root *a*. I found the plant still continue equally vigorous as before. In the spring of 1818, I took away the pot *c*, which I had for some time kept dry, and exposed the roots gradually, as I had formerly done with those in the original pot. I may observe, that in both cases the plant began to push out young shoots and leaves, rather earlier on the branches on the *opposite* side of the tree to that to which the pot was attached; the difference, however, was very inconsiderable.

The pot *d*, which now alone supported the plant, was four feet from the lower end of the stem, and very near to the extremity of the branch, the original roots, and the second set of roots, both hanging loose in the air. The plant, however, remained in this state for nearly a year, in perfect health. In May 1819, I took a very small pot, about two inches in diameter, *e*, and filled it with earth as I had done the others, and set it on the surface of the earth in the pot *d*, which now supported the plant. Into this small pot I introduced a root which came from the same branch, a little below the one which was in the larger pot. As soon as the small pot *e* was filled with roots, I supplied it freely with water, and gave the larger pot none but what might happen to run through the small one. After remaining in this state for near two months, I cut the branch off between the two pots; I still supplied the small pot only with water, but occasionally at this time threw a little water over the whole plant. It continued to look as well as it had done before. In July last, 1819, I examined the small pot *e*, and found it completely filled with roots, very little earth remaining in the pot: by this time the plant appeared to me to be very tenacious of life, and I determined to try whether it would live wholly *without earth*. I accordingly took the small pot off, and gradually worked off what little earth remained among the roots. I at this time, however, threw plenty of water over the leaves, generally twice in the day; this was done about the latter end of July, when the weather was very warm, but it seemed to have no bad effects on the Ficus. The plant, I may remark, could not have been in a warmer part of the stove, being close to the roof, where the stove is always the hottest, and quite exposed to the full rays of the sun.

The branch which had been cut off, was kept growing in a pot of earth in the usual way, close beside the original plant in the stove; and both appeared on an equality as to health and vigour. What may appear rather remarkable is, that though this ficus is a plant by no means free in producing fruit in the usual way of cultivating it, this specimen, quite suspended without a particle of earth, was loaded with figs during the months of September, October, and part of November. Two fruit were produced at the axilla of almost every leaf; and these were quite as large as I had ever seen on the plant in the hot-houses of Kew Garden. Most of them dropped off during the latter end of November or beginning of December, and indeed some of the leaves dropped at the same time. This was partly owing to the strong fires which it was necessary to keep in the house at that time, and to the plant being placed in the hottest part of the stove immediately over the flue where it first enters the house. The usual temperature of the house with fire heat is between 55° and 60° Fahr., and where the fig was suspended, it must have frequently been between 70° and 80° of Fahr. I kept the plant in this local situation, that I might water it freely at all times without the risk of injuring any other plant below it. I have generally sprinkled water on it twice in the day during winter. The falling of the fruit and the few leaves happened only at the first application of fire heat to the stove; in about ten days after, it seemed to get used to the fire heat, which now appeared to have no bad effects on it, although the fires were much stronger afterwards than they were at the time the fruit and leaves dropped off. The original plant now looks nearly as well as the separated one which is growing in a pot close beside it. It is even beginning to grow or extend although it has now been suspended for eight months wit [illegible] of earth, and during that time we have had ve [illegible] and also very cold weather. Roots have been [illegible] reely all over the stem and branches during that time. The plant now measures 7½ feet between the extremity of the root and the top of the branches, and the stem at the thickest part is 5½ inches in circumference.

The two drawings are very correct representations of the plant in its different stages, and for which I am indebted to the kindness of R. K. Greville, Esq.

BOTANIC GARDEN,
18*th February* 1820.

ART. XIV.—*Description of a new method of forming Crucibles.* By Mr CHARLES CAMERON, Glasgow. Communicated by the Author *.

THE Dutch have long enjoyed an almost exclusive monopoly in the manufacture of the small melting-pot or clay crucible, used by the jeweller and silver-smith. The English potter has hitherto failed in imitating those imported from Holland, either in point of shape or quality, in sustaining the sudden transitions of temperature to which they are subjected. In consequence of their superiority, they were an article of great interest to the jeweller during the period of the last war; sometimes they could not be procured, and at other times they sold at five and six times their present price. The English melting-pot was then in request from necessity; it is now entirely out of the market. About two years ago I was led, by a curious train of reasoning, to conceive the practicability of forming crucibles similar to the Dutch, by a simple method, that of moulds made of sulphate of lime or stucco, which would easily give any required form.

I established a small manufactory of them, and carried it on for some time, but owing to particular circumstances I was obliged to relinquish it, after it had arrived at a state of perfection. Having found it to be the opinion of my friends that the process should not be lost, I have been induced to draw up the following account of it for the Edinburgh Philosophical Journal.

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* Along with this article, Mr Cameron has transmitted to us two of his stucco moulds and a bottle of the slip or fluid clay, with which we have repeatedly made several crucibles. The process is undoubtedly one of the most simple and beautiful applications of a scientific principle to the arts that can be imagined, and one not very likely to occur to ordinary minds. We are glad to learn that the Magistrates of Glasgow have adjudged to Mr Cameron, for this process, the premium of Ten Guineas, which they give annually for useful inventions.—ED.

For each of the different sizes of the crucibles, I formed ten or twelve dozen of moulds of stucco, burnt and powdered in the usual manner. For the first mould of each size, I formed a piece of soft pipe-clay into the shape of the intended crucible, and laid it with its mouth downwards on a flat surface, and inclosed it with a cylinder of white-iron, distant about half an inch from the angular points of the crucible, and about an inch and a half higher than its bottom; then, mixing the stucco with water, poured it into the cylinder. When the stucco was sufficiently set, I removed the white-iron, picked out the clay, and dried the mould; I then squeezed soft clay into the mould, which, on standing a few minutes, easily came out again. It was inclosed in the cylinder, and stucco poured round it, which formed a second mould, continuing to do so until I had procured the number wanted. They were then all put into a stove, and completely dried ready for use.

In the preparation of the fire-clay for the crucibles, I followed precisely the same process used at the potteries, by mixing it with a very large quantity of water, and putting the whole through a No. 9. silk search. On allowing the whole to stand a few hours the clay subsided, and in pouring off the clear water, I procured the clay or slip of the consistence of thick cream. On weighing a gallon of it, I found the proportion of clay it contained, and added sand to the whole, in the proportion of seven of sand to seventeen of clay: I then stirred and mixed the whole completely, when it was ready for use. I next took my moulds, previously dried, and arranged them in parallel rows on a table, and successively filled them with the prepared slip. By the time I had filled four or five dozen, I returned to the one first filled, and began alternately to pour the slip out of them, leaving a small quantity unpoured out, which subsided, and gave the requisite thickness to the bottom. In each of the mould [illegible] a crucible is completely formed by the abstraction of [illegible] e slip, in contact with, and adjoining to, the por [illegible] the stucco mould. The crucible will be either [illegible] in proportion to the time the slip has remained in it. Five or six dozen will not require more than fifteen minutes in being formed. The moulds with their contents are then removed to a stove, placed on their side, and built one above the other. In a short time, from the contraction of the clay, the crucibles easily part from the moulds, and are removed by introducing the finger into them. The moulds are allowed to remain in their situation until the water they had absorbed is completely evaporated, when they are again ready for refilling, and will last for years. The crucibles remain in the stove until dry, after which they are burned in a kiln in the usual manner.

The process is simple, and combines the advantages of forming them with great facility, and giving them the required shape, which cannot be accomplished at once on the potter's wheel. One man and a boy are capable of making from ten to twelve hundred *per* day. The principle is peculiarly adapted for the formation of a number of chemical apparatus, muffles, retorts, tubes, &c.

GLASGOW, 11*th May* 1820.

ART. XV.—*Account of the Great Cavern of the Guacharo.* By Baron ALEXANDER DE HUMBOLDT [*].

WHAT gives most celebrity to the valley of Caripe, beside the extraordinary coolness of the climate, is the great *Cueva* or Cavern of the *Guacharo.* In a country where the people love what is marvellous, a cavern that gives birth to a river, and is inhabited by thousands of nocturnal birds, the fat of which is employed in the Missions to dress food, is an everlasting object of conversation and discussion. Scarcely has a stranger arrived at Cumana, when he is told of the stone of Araya for the eyes; of the labourer of Arenas who suckled his child; and of the cavern of Guacharo, which is said to be several leagues in length; till he is tired of hearing of them. A lively interest in the phenomena of nature is preserved wherever society may be said to be without life; where, in dull monotony, it presents only simple relations little fitted to excite the ardour of curiosity.

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[*] Abridged from his Personal Narrative, vol. iii.

The cavern, which the natives call *a mine of fat,* is not in the valley of Caripe itself, but at three short leagues distance from the convent, towards the west-south-west. It opens into a lateral valley, which terminates at the *Sierra del Guacharo.* We set out toward the Sierra on the 18th of September, accompanied by the Alcaids, or Indian magistrates, and the greater part of the monks of the Convent. A narrow path led us at first during an hour and a half toward the south, across a fine plain, covered with a beautiful turf. We then turned toward the west, along a small river, which issues from the mouth of the cavern. We ascended during three quarters of an hour, walking sometimes in the water, which was shallow, sometimes between the torrent and a wall of rocks, on a soil extremely slippery and miry. The falling down of the earth, the scattered trunks of trees over which the mules could scarcely pass, and the creeping plants that covered the ground, rendered this part of the road fatiguing.

At the foot of the lofty mountain of Guacharo, we were only four hundred steps from the cavern, without yet perceiving the entrance. The torrent runs in a crevice, which has been hollowed out by the waters; and we went on under a cornice, the projection of which prevented us from seeing the sky. The path winds like the river: at the last turning we came suddenly before the immense opening of the grotto. The aspect of this spot is majestic even to the eye of a traveller accustomed to the picturesque scenes of the higher Alps. I had before this seen the caverns of the Peak of Derbyshire, where, extended in a boat, we traversed a subterranean river, under a vault of two feet high. I had visited the beautiful grotto of Treshemienshiz, in the Carpathian Mountains, the caverns of the Hartz, and those of Franconia, which are vast cemeteries* of bones of tygers, hyenas, and bears, as large as our horses. Nature in every zone follows immutable laws in the distribution of rocks, in the exterior form of mountains, and even in those tumultuous changes, which the exterior crust of our planet has undergone. So great a uniformity led me to believe, that the aspect of the cavern of Caripe would differ little from what I had observed in my preceding travels. The reality far exceeded my expectations. If the configuration of the grottoes, the splendor of the stalactites, and all the phenomena of inorganic nature, present striking analogies, the majesty of equinoxial vegetation gives at the same time an individual character to the aperture of the cavern.

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* The mould, that has covered for thousands of years the soil of the caverns of Gaylenreuth and Muggendorf in Franconia, emits even now choke-damps, or gaseous mixtures of hydrogen [illegible] that rise to the roof of these caves. This fact is known to all those [illegible]verns to travellers; and when I had the direction of the mines [illegible] observed it frequently in the summer time.

The Cueva del Guacharo is pierced in the vertical profile of a rock. The entrance is toward the south, and forms a vault eighty feet broad, and seventy-two feet high. This elevation is but a fifth less than that of the colonnade of the Louvre. The rock, that surmounts the grotto, is covered with trees of gigantic height. The mammee-tree, and the genipa with large and shining leaves, raise their branches vertically toward the sky; while those of the courbaril and the erythrina form, as they extend themselves, a thick vault of verdure. Plants of the family of pothos with succulent stems, oxalises, and orchideæ of a singular structure, rise in the driest clefts of the rocks; while creeping plants, waving in the winds, are interwoven in festoons before the opening of the cavern. We distinguished in these festoons a bignonia of a violet-blue, the purple dolichos, and for the first time that magnificent olandra, the orange flower of which has a fleshy tube more than four inches long. The entrances of grottoes, like the view of cascades, derive their principal charm from the situation, more or less majestic, in which they are placed, and which in some sort determines the character of the landscape. What a contrast between the Cueva of Caripe, and those caverns of the North crowned with oaks and gloomy larch-trees!

But this luxury of vegetation embellishes not only the outside of the vault, it appears even in the vestibule of the grotto. We saw with astonishment plantain-leaved heliconias eighteen feet high, the praga palm-tree, and arborescent arums, follow the banks of the river even to those subterranean places. The vegetation continues in the cave of Caripe, as in those deep crevices of the Andes, half excluded from the light of day; and does not disappear, till, advancing in the interior, we reach thirty or forty paces from the entrance. We measured the way by means of a cord: and we went on about four hundred and thirty feet, without being obliged to light our torches. Day-light penetrates even into this region, because the grotto forms but one single channel, which keeps the same direction from south-east to north-west. Where the light begins to fail, we heard from afar the hoarse sounds of the nocturnal birds, sounds which the natives think belong exclusively to those subterraneous places.

The guacharo is of the size of our fowls, has the mouth of the goatsuckers and procnias, and the port of those vultures, the crooked beak of which is surrounded with stiff silky hairs. It forms a new genus, very different from the goatsucker by the force of its voice, by the considerable strength of its beak, containing a double tooth, by its feet without the membranes that unite the anterior phalanxes of the claws. It is the first example of a nocturnal bird among the *passeres dentirostrati.* In its manners it has analogies both with the goatsuckers and the alpine crow. The plumage of the guacharo is of a dark bluish-grey, mixed with small streaks and specks of black. Large white spots, which have the form of a heart, and which are bordered with black, mark the head, the wings, and the tail. The eyes of the bird are hurt by the blaze of day; they are blue, and smaller than those of the goatsuckers. The spread of the wings, which are composed of seventeen or eighteen quill feathers, is three feet and a half. The guacharo quits the cavern at night-fall, especially when the moon shines. It is almost the only frugiferous nocturnal bird that is yet known; the conformation of its feet sufficiently shows, that it does not hunt like our owls. It feeds on very hard fruits; as the nut-cracker and pyrrhocorax. The latter nestles also in clefts of rocks, and is known under the name of *night-crow.* The Indians assured us, that the guacharo does not pursue either the lamellicornous insects, or those phalænæ which serve as food to the goatsuckers. It is sufficient to compare the beaks of the guacharo and goatsucker, to conject [illegible] ow much their manners must differ. It is difficult to form [illegible] horrible noise occasioned by thousands of these b [illegible] part of the cavern, and which can only be con [illegible] king of our crows, which, in the pine forests of the north, live in society, and construct their nests upon trees, the tops of which touch each other. The shrill and piercing cries of the guacharoes strike upon the vaults of the rocks, and are repeated by the echo in the depth of the cavern. The Indians showed us the nests of these birds, by fixing torches to the end of a long pole. These nests were fifty or sixty feet high above our heads, in holes in the shape of funnels, with which the roof of the grotto is pierced like a sieve. The noise increased as we advanced, and the birds were affrighted by the light of the torches of copal. When this noise ceased around us, we heard at a distance the plaintive cries of the birds roosting in other ramifications of the cavern. It seemed as if these bands answered each other alternately.

The Indians enter into the Cueva del Guacharo once a-year, near midsummer, armed with poles, by means of which they destroy the greater part of the nests. At this season several thousands of birds are killed; and the old ones, as if to defend their brood, hover around the heads of the Indians, uttering terrible cries. The young, which fall to the ground, are opened on the spot. Their peritoneum is extremely loaded with fat, and a layer of fat reaches from the abdomen to the anus, forming a kind of cushion between the legs of the bird. This quantity of fat in frugiferous animals, not exposed to the light, and exerting very little muscular motion, reminds us of what has been long since observed in the fattening of geese and oxen. It is well known how favourable darkness and repose are to this process. The nocturnal birds of Europe are lean, because, instead of feeding on fruits like the guacharo, they live on the scanty produce of their prey. At the period which is commonly called at Caripe *the oil harvest*, the Indians build huts with palm leaves, near the entrance, and even in the porch of the cavern. Of these we still saw some remains. There, with a fire of brushwood, they melt in pots of clay the fat of the young birds just killed. This fat is known by the name of butter or oil *(manteca* or *aceite)* of the guacharo. It is half liquid, transparent, without smell, and so pure that it may be kept above a year without becoming rancid. At the convent of Caripe no other oil is used in the kitchen of the monks but that of the cavern; and we never observed, that it gave the aliments a disagreeable taste or smell.

The quantity of this oil collected little corresponds with the carnage made every year in the grotto by the Indians. It appears that they do not get above 150 or 160 bottles (sixty cubic inches each) of very pure *manteca;* the rest, less transparent, is preserved in large earthen vessels. This branch of industry reminds us of the harvest of pigeon's oil *, of which some thousands of barrels were formerly collected in Carolina. At Caripe, the use of the oil of guacharoes is very ancient, and the missionaries have only regulated the method of extracting it. The members of an Indian family, which bears the name of Morocomas, pretend, as descendants of the first colonists of the valley, to be the lawful proprietors of the cavern, and arrogate to themselves the monopoly of the fat; but, thanks to the monastic institutions, their rights at present are merely honorary. In conformity to the system of the missionaries, the Indians are obliged to furnish guacharo-oil for the church-lamp: the rest, we were assured, is purchased of them. We shall not decide either on the legitimacy of the rights of the Morocomas, or on the origin of the obligation imposed on the natives by the monks. It would seem natural, that the produce of the chace should belong to those who hunt: but in the forests of the New World, as in the centre of European cultivation, public right is modified according to the relations which are established between the strong and the weak, the victors and the vanquished.

The race of the guacharoes would have been long ago extinct, had not several circumstances contributed to its preservation. The natives, restrained by their superstitious ideas, have seldom the courage to penetrate far into the grotto. It appears, also, that birds of the same species dwell in neighbouring caverns, which are too narrow to be accessible to man. Perhaps the great cavern is repeopled by colonies, that abandon the small grottoes; for the missionaries assured us, that hitherto no sensible diminution of the birds had been observed. Young guacharoes have been sent to the port of Cumana, and have lived there several days without taking any nourishment; the seeds offered to them not suiting their t When the crops and gizzards of the young birds are opened in the cavern, they are found to contain all sorts of hard and dry fruits, which furnish, under the singular name of guacharo seed, *semilla del guacharo*, a very celebrated remedy against intermittent fevers. The old birds carry these seeds to their young. They are carefully collected, and sent to the sick at Cariaco, and other places of the low regions, where fevers are prevalent.

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* This *pigeon oil* come igratoria, (Pennant's Arctic Zoo-gy, vol. ii. p. 13.)

We followed, as we continued our progress through the cavern, the banks of the small river which issued from it, and is from twenty-eight to thirty feet wide. We walked on the banks, as far as the hills formed of calcareous incrustations permitted us. When the torrent winds among very high masses of stalactites, we were often obliged to descend into its bed, which is only two feet in depth. We learnt, with surprise, that this subterraneous rivulet is the origin of the river Caripe, which, at a few leagues distance, after having joined the small river of Santa Maria, is navigable for canoes. It enters into the river Areo under the name of *Canno de Terezen.* We found on the banks of the subterraneous rivulet a great quantity of palm-tree wood, the remains of trunks, on which the Indians climb to reach the nests hanging to the roofs of the cavern. The rings, formed by the vestiges of the old footstalks of the leaves, furnish as it were the footsteps of a ladder perpendicularly placed.

The Grotto of Caripe preserves the same direction, the same breadth, and its primitive height of sixty or seventy feet, to the distance of 1458 feet, accurately measured. I have never seen a cavern in either continent, of so uniform and regular a construction. We had great difficulty in persuading the Indians to pass beyond the outer part of the grotto, the only part which they annually visit to collect the fat. The whole authority of *los padres* was necessary, to induce them to advance as far as the spot where the soil rises abruptly at an inclination of sixty degrees, and where the torrent forms a small subterraneous cascade*. The natives connect mystic ideas with this cave, inhabited by nocturnal birds; they believe, that the souls of their ancestors sojourn in the deep recesses of the cavern. "Man," say they, "should avoid places which are enlightened neither by the Sun nor by the Moon." To go and join the guacharoes, is to rejoin their fathers, is to die. The magicians and the poisoners perform their nocturnal tricks at the entrance of the cavern, to conjure the chief of the evil spirits.

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* We find this phenomenon of a subterranean cascade, but on a much larger scale, in England at Yordas Cave, near Kingsdale, in Yorkshire.

At the point where the river forms the subterraneous cascade, a hill covered with vegetation, which is opposite the opening of the grotto, presents itself in a very picturesque manner. It appears at the extremity of a straight passage, 240 toises in length. The stalactites, which descend from the vault, and which resemble columns suspended in the air, display themselves on a back-ground of verdure. The opening of the cavern appeared singularly contracted, when we saw it about the middle of the day, illumined by the vivid light reflected at once from the sky, the plants, and the rocks. The distant light of day formed somewhat of magical contrast with the darkness that surrounded us in those vast caverns. We discharged our pieces at a venture, wherever the cries of the nocturnal birds, and the flapping of their wings, led us to suspect that a great number of nests were crowded together. After several fruitless attempts, M. Bonpland succeeded in killing a couple of guacharoes, which, dazzled by the light of the torches, seemed to pursue us. This circumstance afforded me the means of drawing this bird, which hitherto had remained unknown to naturalists. We climbed, not without some difficulty, the small hill, whence the subterraneous rivulet descends. We saw that the grotto was perceptibly contracted, retaining only forty feet in height; and that it continued stretching to the north-east, without deviating from its primitive direction, which is parallel to that of the great valley of Caripe.

In this part of the cavern, the rivulet deposits a blackish mould, very like the matter which, in the grotto of Muggendorf in Franconia, is called the *earth of sacrifice*. We could not discover, whether this fine and spongy mould fall through the cracks which [illegible]icate with the surface of the ground above, or be wasl[illegible]e rain-water that penetrates into the cavern. I[illegible]f silex, alumen, and vegetable *detritus*. We wa[illegible]d to a spot, where we beheld with astonishment the progress of subterraneous vegetation. The seeds, which the birds carry into the grotto to feed their young, spring up wherever they can fix in the mould, that covers the calcareous incrustations. Blanched stalks, with some half-formed leaves, had risen to the height of two feet. It was impossible to ascertain the species of plants, the form, colour, and aspect of which had been changed by the absence of light. Those traces of organization amid darkness, forcibly excited the curiosity of the natives, in general so stupid, and difficult to be moved. They examined them in that silent meditation inspired by a place they seemed to dread. It might be thought, that these subterraneous vegetables, pale and disfigured, appeared to them phantoms banished from the face of the earth. To me the scene recalled one of the happiest periods of my early youth, a long abode in the mines of Freiberg, where I made experiments on the effects of blanching, which are very different, according as the air is pure, or overcharged with hydrogen or azote.

The missionaries, with all their authority, could not prevail on the Indians to penetrate farther into the cavern. As the vault grew lower, the cries of the guacharoes became more shrill. We were obliged to yield to the pusillanimity of our guides, and trace back our steps. The appearance of the cavern was indeed very uniform. We find, that a bishop of St Thomas of Guiana had gone farther than ourselves. He had measured nearly 2500 feet from the mouth to the spot where he stopped, though the cavern reached farther. The remembrance of this fact was preserved in the convent of Caripe, without the exact period being noted. The bishop had provided himself with great torches of white wax of Castile. We had torches composed only of the bark of trees and native resin. The thick smoke which issues from these torches, in a narrow subterranean passage, hurts the eye, and obstructs the respiration.

We followed the course of the torrent to go out of the cavern. Before our eyes were dazzled with the light of day, we saw, without the grotto, the water of the river sparkling amid the foliage of the trees that concealed it. It was like a picture placed in the distance, and to which the mouth of the cavern served as a frame. Having at length reached the entrance, and seated ourselves on the bank of the rivulet, we rested after our fatigues. We were glad to be beyond the hoarse cries of the birds, and to leave a place where darkness does not offer even the charm of silence and tranquillity. We could scarcely persuade ourselves, that the name of the Grotto of Caripe had hitherto remained unknown in Europe. The guacharoes alone would have been sufficient to render it celebrated. These nocturnal birds have been nowhere yet discovered, except in the mountains of Caripe and Cumanacoa.

The cavern of Caripe, situated nearly in the latitude of 10° 10′, consequently in the centre of the torrid zone, is elevated 506 toises above the level of the water in the Gulf of Cariaco. We found in every part of it, in the month of September, the temperature of the interior air between 64°.6 and 66° of Fahrenheit; the external atmosphere being at 61°.2. At the entrance of the cavern, the thermometer in the air was at 63°.7; but when immersed in the water of the little subterraneous river, it marked, even to the end of the cavern, 62°.2.

Art. XVI.—*On the fluctuating Sensibility of the Retina.* By Mr Thomas Smith, Surgeon, Kinguissie. Communicated by the Author.

The phenomena of Accidental Colours have been attempted to be accounted for, on the principle that the sensibility of the retina is diminished by the action of light. "The eye," says the celebrated Cuvier, "sometimes sees what are called Accidental Colours. When the retina is too much fatigued by certain colours, it becomes less sensible of them. If we then behold a colour which admits in its composition that which had fatigued the eye, the latter will cease to be visible. Thus, when we fix the eye on a white spot, and afterwards turn it to white bodies, we observe on them a dark spot of the same shape as that to which the eye was first directed. If the spot on which the eye was fixe[illegible] the eye, wherever it turns, will perceive one of a [illegible] If it was red, we perceive a greenish spot on [illegible] yellow, a bluish; if green, a reddish," &c.

That the sensibility of the retina, however, is less impaired in certain circumstances by the action of light, than it is increased in darkness, appears evident from the following facts.

If we look on an uniformly red surface, occupying the whole sphere of vision, for about half a minute, it will not appear darker at the end of that time than it did at first, provided the eye was before accustomed to that degree of light. But if the eye is then turned from the red to a white surface, the latter will appear greenish; which shews that the sensibility of the retina, although not perceptibly diminishing to red light while viewing the red surface, is yet increasing to all the other primary colours to which, at the time, the eye is in a comparative state of darkness.

Again; after looking long and steadily on the centre of a red circle on a white or black ground, the red colour becomes fainter and fainter, till at last the circle appears almost or altogether white. Dr Darwin was of opinion that the perception, in this case, becomes every instant weaker and weaker. But the circumstance of the red circle appearing *white*, which seems to have escaped his notice, indicates a greater increase of sensibility to the other simple rays of light proceeding from the coloured circle, than decrease to the red light.

But neither the decrease of the sensibility by the action of light, nor its increase in darkness, can alone account for all the phenomena of accidental colours. Thus the accidental colour of a small white or black circle upon a red, yellow, or other primary coloured ground, is not the reverse of the circle viewed, but the same as the ground it was viewed upon.

The cause of this may be traced to a remarkable fluctuation in the state of the sensibility of the retina, which occurs *during* and *after* the eye is exposed to a stronger light in the vicinity of a weaker. As no notice, I believe, has been taken of this fluctuating sensibility of the retina by writers on vision, a brief account of it may perhaps be not unacceptable to some of the readers of this Journal.

It may appear a singular position, that at the time of viewing a stronger and weaker light together, the sensibility of the retina is increased to the stronger light, and diminished to the weaker. Yet if the facts I am about to mention shall, upon trial, be found to agree with the experience of others, it will not be denied that the sensation produced by the greater light is greater, and that produced by the weaker light is less, than what is produced by these different degrees of light when they occupy singly the whole sphere of vision.

Experiment 1.—When I fix my eyes steadily on the centre of a white circle, about an inch in diameter, upon an extensive blackish ground, the white circle appears surrounded by a halo darker than the rest of the ground, shewing a decrease of the sensibility of the retina in the parts adjacent to that which was acted upon by the greater light. But when I view a *black* circle upon a *white* ground, the black circle appears surrounded by a halo whiter than the rest of the ground, shewing an increase of sensibility to the greater light in the vicinity of the lesser.

There is a degree of steadiness of the eyes required at the time of performing this experiment, which those who are not accustomed to the like, may find difficult to practise at first; for the *eyes* are apt to turn to whatever part the *attention* is directed, which prevents the results I have mentioned from being obtained.

The *halo* mentioned above, and in other parts of this paper, becomes fainter as it receded from the object it surrounds, and with moderate light is found to occupy an area equal, as far as I could ascertain by measurement, to that of the object viewed. But with very brilliant objects, such as the sun, the area of the halo is considerably greater.

Experiment 2.—I provided myself with two tubes, each about an inch in diameter, and four inches long, one of them opaque, and blackened within; the other thin, white, and transmitting freely through its sides the rays of light. Then ascertaining that both eyes were equally sensible to light, I looked at a uniform white wall moderately illuminated, with one eye through the white tube, and with the other eye naked, and observed that *when the inside of the tube was more illuminated than the wall*, the [illegible]f the latter which was seen through the tube appeared [illegible] did to the naked eye. Again, the eyes being e[illegible]n looking at the same wall with one eye thro[illegible]be, and with the other eye naked, I found that the wall appeared brighter to the former than to the latter.

I select the following experiment out of a very great number which might be given, to prove that the increased sensibility to the greater light, and the diminished sensibility to the lesser, above shown, are not to all kinds of light indiscriminately, but only to the same primitive colour or colours.

Experiment 3.—I took several slips of thin writing paper, four inches long, and three inches broad. One of these I painted on both sides red; another yellow; a third green; a fourth blue, &c. By applying a black tube to one eye, and one of the coloured tubes to the other, I could compare together the different appearances, if any, which a white surface assumed when viewed through these different tubes. I could also compare the different appearances of the same surface as seen through any two of these coloured tubes at once. In either way the effects were very striking. The same white surface, which through a black tube appeared bright white, appeared greenish through a red tube; purple through a yellow; red through a green, &c.

As my object is to give a faithful account of the principal results of my observations upon the state of the sensibility of the retina at the time of, and after, viewing surfaces unequally illuminated, I must not omit the following singular one.

Experiment 4.—In the centre of a thin board I cut a circular hole, one inch in diameter. Having covered one side of the board with thin writing paper, I painted all of it, except so much as extended over the hole, of a deep black colour. The circular part which remained white I wetted with olive oil, to enable it to transmit light more freely. Thus prepared, I placed the board perpendicular to the horizon, between my eyes and the flame of a candle, the oiled circle being about an inch from, and directly opposite the flame. Then fixing my eyes steadily on the centre of the brilliant white, or more correctly speaking, yellowish circle, it appeared in the course of some seconds to be surrounded by a broad purple halo, which also was surrounded in most instances by a yellowish halo.

That the part of the retina contiguous to that upon which the rays of light from the yellowish circle fell, was, by their action, rendered less sensible to yellow light, the former experiments lead me to conclude: but that it should at the same time become so much more sensible to all the other kinds of light, as to perceive, not dimly, but distinctly, the very few, if any there were, of these rays which, in the way the board was placed, could be reflected from the black surface, is highly improbable; and the more so, that I have never found this halo produced but when the object viewed was brilliant. I am therefore inclined to believe that the part of the retina answering to the halo in this experiment, was, without the direct agency of purple light, thrown into a state similar to that which is produced by such light, and that the external yellowish halo was produced in a similar manner.

These are the principal results of my observations on the state of the sensation produced, and sensibility of the retina, *at the time of viewing* unequally illuminated surfaces. I shall now proceed to shew the singular reflux which occurs afterwards.

Experiment 5.—After looking steadily for about half a minute on the centre of a small white circle, upon an extensive blackish ground, as in the 1st experiment, if the eyes are turned to another part of the black ground, a very black circle will appear surrounded by a bright halo; from which it is evident that the sensibility undergoes a remarkable change of viewing the white circle, being *diminished* where the sensation was *increased*, and *increased* where the sensation was *diminished.*

Experiment 6.—When the eyes are steadily fixed on the centre of a red circle an inch in diameter, on a white ground a foot or more square, the red circle appears surrounded by a greenish halo. If the distance between the red circle and the eyes is then increased, still looking steadily at the centre of the red circle, part of the spectrum or accidental colour of the red circle will be allowed to form, and the red circle will appear surrounded by a *green ring* and *red* halo.

Experiment 7.—After looking steadily at the centre of the oiled paper mentioned in the 5th experiment, till the halo appeared brilliant, I t[illegible] my eyes to another part of the black paper, and saw a [illegible] spectrum, surrounded by a greenish-yellow ha[illegible] eyes were turned to a white wall, the spectrun[illegible] less vivid; but what is still more remarkable, when I closed my eyes, and covered them with several folds of black cloth to exclude the light, the spectrum and halo appeared more brilliant than when the eyes were opened upon a white wall.

This experiment has been often repeated by myself and others, with every precaution to keep out the light, but invariably the spectrum and halo have been found brighter the more perfectly the light was excluded from the eyes.

When the degree of light proceeding from the more luminous body or surface is not so great as to dazzle the eyes, I have found the state of the sensibility, after viewing the object, to be exactly the reverse of what it was at the time the eyes were fixed upon it. But when the eyes bore with difficulty the quantity of light reflected or emitted from the more luminous object, the same regular reverse accidental colours were not obtained. One thing, however, is remarkable, that the colours of the spectrum and halo are, in such cases, as far as I have found, exactly the reverse of one another. Several experiments exemplifying this, though somewhat imperfectly, are on record. I shall subjoin only one.

Experiment 8.—This experiment was made with my eyes shut and closely covered up from the light; after I had looked steadily at the centre of the oiled paper, described in experiment 5., placed between the sun and my eyes, till the halo became vivid. The whole experiment took up several minutes, and the numbers refer to the observations made at intervals during that time.

1. Spectrum yellow, with a reddish border: bluish purple halo. 2. Spectrum disappeared. 3. Yellow spectrum: purple halo. 4. Disappeared. 5. Red spectrum, surrounded by diffused greenness. 6. Disappeared. 7. Deeper red spectrum: light green halo. 8. Disappeared; but suddenly 9. Purple spectrum: yellow halo. 10. Disappeared. 11. Darker purple spectrum, surrounded by diffused light-yellow. 12. Disappeared. 13. Broken down spectrum, which became gradually fainter, till it finally disappeared.

Having thus given a sketch of the principal facts which I have observed upon the state of the sensibility of the retina at the time of, and after viewing equally and unequally illuminated surfaces, I shall conclude with the following summary:

1. While viewing a coloured surface occupying the whole sphere of vision, the sensation is less decreased than the sensibility is increased in darkness in a given time.
2. While the retina is acted upon by a stronger and weaker light together, the sensation produced by the stronger light is greater, and the sensation produced by the weaker light less, than what is produced by these different degrees of light when they occupy singly the whole sphere of vision.
3. After the retina is acted upon by a stronger and weaker light together, the sensibility is increased where the sensation (2.) was diminished, and diminished where the sensation was increased.
4. In certain circumstances the retina, without the direct agency of light, is thrown into the same state which light produces. Experiments 4. 7. and 8.

Art. XVII.—*Notice respecting a Singular Structure in the Diamond.* By David Brewster, LL.D. F.R.S. Lond. and Sec. R.S. Edin [*].

Having been lately engaged in examining the optical structure of *Amber* [†], I was surprised to observe that it exhibited phenomena almost exactly the same as those which I had long ago noticed in several flat *Diamonds*, which belonged to Mr Robison, a member of this Society. In order to compare the two structures with greater attention, I re-examined nine of Mr Robison's diamonds. In all of them I remarked that the polarised tints were arranged in streaks, like those developed by amber; but one of the diamonds exhibited a new phenomenon of a most unexpected kind, which is the only fact in the natural history of this body that promises to throw light upon its origin and mode of formation.

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[*] This notice wa [illegible] Royal Society of Edinburgh, on the 3d April 1820.

[†] See this *Journ* [illegible]

Had the diamond not been placed at the head of the mineral kingdom, from its unrivalled lustre, and high value as an ornamental gem, it would have attained the same distinction from its great utility in the arts. Separated from all other gems by its remarkable refractive power, and from all mineral substances by its extreme hardness, its chemical composition, and its locality in the crust of the earth, it has always been regarded as an anomalous substance, which set even speculation at defiance.

When Sir Isaac Newton compared the refractive power of several bodies, he remarked that amber and the diamond had a refractive power three times greater, in respect of their densities, than several other substances, and he conjectured that the diamond was " probably an unctuous substance coagulated." This relation between the inflammability of bodies and their absolute refractive power, I had an opportunity of confirming and extending, by ascertaining that *Sulphur* and *Phosphorus* exceed even the diamond in absolute refractive power, and that the three simple inflammable bodies stood at the head of all other solid and fluid substances in their absolute action upon light *.

In this arrangement *Amber* stood next to *Diamond*, and as both these substances had a similar locality, and had also *carbon* for their base, it became of some importance to discover that their general polarising structure was the same. The analogy, however, to which I wish to direct the attention of the Society, is founded *on the existence of small portions of air within both substances, the expansive force of which has communicated a polarising structure to the parts in immediate contact with the air.* This structure is displayed by four sectors of polarised light encircling the globule of air, and can be produced artificially either in glass or in gelatinous masses, by a compressing force propagated circularly from a point. It is obvious that such an effect cannot arise from any mode of crystallization, and if any proof of this were necessary, it might be sufficient to state, that I have never observed the slightest trace of it in more than 200 mineral substances which I have examined, nor in any of the artificial salts formed from aqueous solutions. It can therefore arise only from the expansive force exerted by the included air on the *diamond* and the *amber*, when *they were in such a soft state as to be susceptible of compression from so small a force.* That this compressible state of the diamond could not arise from the action of heat, is manifest from the nature and the recent formation of the soil in which it is found: that it could not exist in a mass formed by aqueous deposition is still more obvious, and hence we are led to the conclusion, rendered probable by other analogies, that the *diamond* originates, like amber, from the consolidation of perhaps vegetable matter, which gradually acquires a crystalline form by the influence of time, and the slow action of corpuscular forces [*].

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* *Treatise on New Phil. Instruments*, p. 266.

As the preceding results were obtained from flat diamonds, which did not seem to have been regularly crystallised, I was anxious to detect the same structure in those which had a regular crystalline form. With this view I examined several of the diamonds in Mr Allan's collection, and was fortunate enough not only to detect in a perfect octohedral crystal the same structure which I had observed in the flat specimens, but also an air-bubble of considerable size, which had produced, by its expansion, the polarising structure already described.

EDINBURGH, *March* 1820.

ART. XVIII.—*Notice regarding the Submarine Remains of a Grove of Fir-Trees in Orkney.* Contained in a Letter from W. G. WATT, Esq. of Skaill, to Mr STEVENSON, Civil Engineer.

ON the west coast of the Mainland of Orkney, about midway between Hoy Mouth and the Westray Frith, lies the Bay of Skaill, almost the only one on this part of the coast. It is completely exposed to all the violence of the western ocean, the waves of which often roll into it with tremendous force.

About three year [illegible] the sand on the shore of this bay was removed by the violent motion of the sea, which had been more than usually agitated by a heavy gale of wind from the south-west. By the removal of the sand, Mr Watt of Skaill discovered, during the ebb, what was apparently a peat-moss, about an acre in extent. Partly imbedded, and lying on the surface of this moss, in a horizontal position, were the stems of several small trees about 10 feet in length, and from 5 to 6 inches in diameter. They were in a very decayed state; but a piece of one of them was so fresh, that Mr Watt was able to ascertain it to be some kind of fir. This is exceedingly remarkable, as no native specimen of any of the resinous or coniferous trees now exists, nor has perhaps for centuries existed, in the Orkney Islands, whose Sylva at this day consists of a few stunted alders and willows. But here a number of trees were found lying across one another, which had seemingly grown in a clump. The stems were still attached to the fibres of their respective roots; and no doubt remained on Mr Watt's mind, that they had grown on the spot where they now lay. To ascertain that fact completely, however, he had a trench dug round two of them, and thus traced the fibres of the roots running in all directions, and of all sizes, but so much decayed that they did not give the least interruption to the spade. Upon removing the surface of what was supposed to be moss, Mr Watt found it to be an accumulation of leaves of vegetables, so much in a state of decay, that they could not be separated without destroying their texture. These resembled in shape and size the leaves of peppermint, or perhaps of some species of willow. There were numerous small seeds intermixed, about the size of turnip-seed, of a reddish colour. In these seeds the power of vegetation appeared totally destroyed; but they were not so much decayed as either the trees or the leaves. After some time, by the action of the sea, the sand again returned to a considerable depth over the moss.

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[*] See *Edin. Phil. Jo* [illegible] and MM. Eyrie and Maltebrun's *Annales des Voyages*, tom.

When Mr Watt had satisfied himself that the trees had grown in the situation described, where the sea at this day rises, during the flood tide, to the depth of at least fifteen feet, it occurred to him, that this bed of moss and trees has arrived at its present level in consequence of the removal of a bank of earth at least eighteen feet deep, which has been washed gradually away by the water of the Loch of Skaill oozing along the rocks upon which it rested, and upon which the mass of leaves now rests, held together by the fibres of the roots of the trees.

Art. XIX.—*Account of the Correspondence between Mr* Park *and Mr* Maxwell, *respecting the Identity of the Congo and the Niger.* By the Rev. William Brown, D. D. Minister at Eskdalemuir. Communicated by the Author *.

It has been for sometime understood among the relations and intimate friends of Mr Park, that the object of his second journey into the interior of Africa was to ascertain the termination of the Niger, and especially whether or not the Congo was the outlet of that river.

The first idea of the identity of the Congo and the Niger, was suggested by Mr William Keir, at Milnholm, near Langholm, Dumfriesshire, in consequence of information which he had obtained (many years before the appearance of Mr Park's Travels) from his friend Mr George Maxwell at Prior's Lynn, in the parish of Canonby, concerning the river Congo, which he had frequently visited in the earlier part of his life as Master of a trading vessel, and of which he had constructed a chart. According to Mr Maxwell, the river Congo, 150 miles from the sea, (the height to which his boats went), is about a mile and a half wide, having from 30 feet depth of water with the boat's side touching the cliff, to 300 feet in the centre, a width and depth which continue the same for 60 or 70 miles farther down, where the river is confined between stupendous precipices of grey rock, fringed with trees. At 27 or 30 miles from the sea, in 6° 10′ south latitude, which may be called its proper mouth, it is about 3 miles broad, and from 20 feet depth of water close in with the shore to 400 feet in the centre. Even at the latter end of the dry season, when it may be supposed to be at the lowest, and in a direct line between the Capes, which is a rude way sometimes adopted to describe the size of rivers, the Congo is about 25 miles wide. The current, or *outset* of the river, is never less, even during the dry season, than 5 and 6 miles an hour, and the general course of the stream, after it enters the ocean, is to the N.W. keeping at the distance of about 60 miles from the shore, until it falls into the Gulf of Guinea, between Cape Lopez and Anna Bona, six degrees to the northward of the Congo, rendering the transparent salt-water there of a dark colour; and, when the stream happens to set to the S.W. and W. which Mr Maxwell has sometimes seen, the ocean has been quite turbid with the fresh water 200 miles from shore; for the Congo has always the appearance of being in flood, or of a red clay colour. In short, according to Mr Maxwell, the Congo is not the inconsiderable river which even Major Rennell's improved map of Africa that accompanies Park's Travels would lead us to suppose, but one of the third or fourth magnitude. For, according to geographers, the Nile and Missisippi occupy these stations, and are both of them said to run a course of 3000 miles; yet what are either of them when compared with the Congo? The Missisippi has only 17 feet water over the bar or entrance; while the Congo has no bar, and has never less than 600 feet depth of water in the stream, with salt-water soundings on either side, from 3 feet close in with the beach, to 100 feet, 30 miles out in the offing, having scooped out for itself a channel in the bed of the ocean. Even the Nile (according to Volney) becomes green, fetid, and full of worms, while the Congo rolls along, seemingly in full flood, until we examine the water-marks which appear on the perpendicular rocks on either side, at the height of 9 or 10 feet above its ordinary surface, and to which it annually rises in December and January.

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* This interesting p[illegible]en kindly communicated to us by Dr Brown, who is in possession of [illegible]ondence. It was drawn up in 1811, and submitted to Mr Ke[illegible]the last of whom made several corrections on the MS.—Ed

Such was the substance of the information which Mr Keir had received from Mr Maxwell; and when reading Mr Park's Travels, it occurred to him, to be a more natural way of disposing of the Niger, by making it communicate with the Congo, than by evaporation from the Lake of Mangara. And, in looking into the Map, he was confirmed in his conjecture; for, from Mangara to the Congo, skirting the Mountains of the Moon to the south-west, the distance is not above two thousand miles; and there seemed no other rational way of accounting for the extraordinary size of the Congo. This conjecture Mr Keir communicated to Mr Maxwell, and afterwards to Mr Park, when at Bowhill near Selkirk, in the neighbourhood of which Mr Park then resided. The idea struck the traveller; he requested and obtained a copy of Mr Maxwell's chart; and I have now lying before me, the whole of the correspondence that took place in consequence of the suggestion. It consists of two letters from Mr Maxwell to Mr Keir, both of which were carried by Mr Park to London; a letter from Mr Park while in London to Mr Maxwell; and two letters from Mr Maxwell to Mr Park in reply. The following narrative is drawn up from these letters, almost in the writers' own words; and the public, I am persuaded, will regret the preponderance of those motives which induced Mr Park to begin at the wrong end of his journey.

In Mr Maxwell's first letter to Mr Keir, dated 1st May 1803, he states it as his opinion, "that Mr Park had been extremely fortunate in the choice of his first route; for he suspects that the chiefs upon the sea-coast, from Cape Palmos along the Bight of Guinea to Cape Lopez, would not suffer a European to penetrate the country on any pretext whatever, as they will not allow the officers of African ships to have the slightest intercourse with the Bushmen or traders from the Interior, and are very jealous of any white person going inland. Nay, even admitting that they were disposed to favour the views of an adventurer, that adventurer would still have to struggle with incalculable hardships from the want of meal and milk, articles which seem to constitute their chief food in North Africa. Whilst, from Cape Lopez to Congo, they have no contrivance that Mr Maxwell knows of to grind or beat their corn, but simply roast or boil it for use. Neither do they abound in yams or potatoes; their chief food being plantains, cassava, Indian corn, &c. seasoned with palm [illegible]pper, and smoked fish, none of which he apprehends wo[illegible] mode of cooking, ever agree with the European [illegible]heir white or sweet cassava (Mayacka mamgo[illegible] raw; but the red or bitter

(Mayacka mansamba) is a virulent poison in that state, and must undergo a certain preparation and boiling, before it can be used as food. Neither would it (on the supposition that the natives would be friendly to such an adventure) be at all practicable on horseback. For, as they have none of those animals themselves, their paths lead over hill and dale, across deep ravines, and along the edge of precipices, without any regard to a mode of travelling which they know nothing about, and where it would be absolutely impossible for a horse to keep his footing. It appears very strange to Mr Maxwell, that the African Association have never thought of conducting their researches into the Interior of Africa by means of the natives; which he considers to be the only infallible and sure mean of prosecuting that mission, by educating a sufficient number of the African youth in the different branches of learning, suited to the duty they are intended to perform, whether as schoolmasters, missionaries, traders, historians, draughtsmen, or naturalists, and rewarding their labours according to the diligence and exertion displayed in their respective callings. Their bodies, being naturalized to the climate, would suffer nothing on that score; and, with a little address, their colour would exempt them from all suspicion,—so that they might travel in perfect safety from one end of Africa to the other. It would indeed take ten or twelve years to fit them for this service, but ever after that it would not meet with any interruption; and we have incontrovertible evidence of their having talents, susceptible of sufficient improvement for such an undertaking."

Mr Maxwell's second letter to Mr Keir, is dated July 20. 1804, fourteen months after the former, during which time Mr Keir had mentioned to Mr Park, his conjecture of the Congo being the mouth of the Niger. It states, that he had sent Mr Park his chart of the river Congo, (published by Lawrie and Whittle,) as he had promised; and that long before Mr Park made us acquainted with the course of the Niger, it had occurred to him that the Congo drew its source far to the northward; from the floods commencing long before any rains take place to the southward of the equator, as it begins to swell perceptibly the latter end of October, and yet no heavy rains set in before December; —remarking, farther, that the heavy rains in both tropics do not commence until the sun has nearly gained his utmost boundary, and is about to return towards the equinoctial line. So that the increase of the Congo from the end of October to the beginning or even middle of December, cannot be ascribed to any rain that falls in South Africa. About the end of January or the beginning of February, the river, he says, may be supposed at its height: but at no time can the rains to the southward of the line be compared with those to the north of it, between the river Volta and Cape Lopez, in what is called the Bight of Guinea. Whether the Congo, therefore, be the outlet of the Niger or not, it offers, in his opinion, the best opening for exploring the interior of Africa, of any scheme that has ever been attempted; and the ease and safety with which it might be conducted, need no comment. If the Niger have a sensible outlet, he has little doubt of its proving the Congo; being acquainted with most of the large rivers between Cape Palmos and Cape Negro: nor need the immense course of such a river as the Congo and Niger in one continued stream, excite much astonishment, when we know that the St Lawrence, contemptible in size compared with the Congo, after traversing a great part of North America, and issuing through a chain of lakes, discharges itself into the Atlantic Ocean: but, instead of five or six lakes, like the St Lawrence, the Congo may be supposed to pass through twice the number, which may in a great measure solve any difficulty as to the floods of the Niger not immediately affecting the Congo. He can say this much, however, for the river Congo, that by comparing it with other rivers, according to the best authorities, it must rank as the third or fourth in magnitude; and, indeed, from the current which it produces in the ocean, carrying out floating islands 60 or 70 leagues from the coast, the Amazons alone can cope with it; of which our poet says, that "Ocean trembles for his blue domain." Many of the traders that he met with at Embomma, had come a journey of one month (gonda) down the river, (which, at 20 miles a day, allowing seven days rest, would make 440 miles,) spoke of it as equally [illegible] where they came from, and that it went by the name of [illegible] does by all the natives on the lower part of the [illegible] when questioned about its urce, Mafooka Coo[illegible] answer to Mr Maxwell, as that which Mr Park received on the banks of the Niger, viz. that it was believed to come from the world's end. It is Mr Maxwell's opinion, that Leyland's or Molyneux's Islands at Embomma, either of which might be rendered almost as strong as Gibraltar at a small expence, would be the finest spots imaginable for establishing an extensive communication with the interior of Africa *. Mr Maxwell adds, that if Mr Keir's idea of the Congo being the outlet of the Niger, prove correct, we may consider it as an opening designed by Providence for exploring those vast regions " where the sun shines, and seasons team in vain;" and for humanizing the wretched natives, by affording ample scope for the enthusiasm of the naturalist, merchant, and missionary.

It was formerly observed, that Mr Park saw these letters, and carried them with him to London, to shew to his patrons. The following letter, therefore, from Mr Park, while in London, to Mr Maxwell, which I shall give *verbatim*, will shew the impression which the communication had made on the minds of the Association.

" DEAR SIR, *London, October* 3. 1804.

" I shewed your chart of the Congo to Lord Camden, Secretary of State, and he is very desirous to obtain further information respecting that river. I have therefore troubled you with this, and request that you will have the goodness to favour me with some information on the following particulars: 1st, Do you recollect the names of any of the inland kingdoms from which the slaves are brought down to the Congo for sale? 2d,

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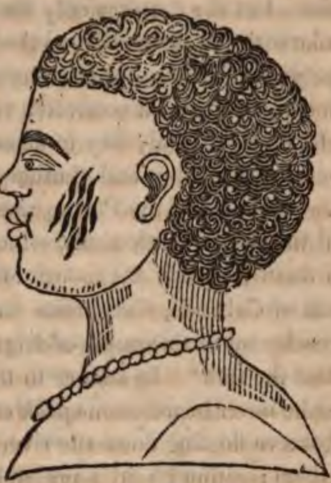
* The situation, indeed, of these islands, must appear to any one who examines the chart, very commanding. The Congo, for 150 miles up, may be divided into three portions. 1st, A united stream 1½ miles wide, from the height to which Mr Maxwell's boat went, down to Embomma, comprehending a distance of 70 miles. 2dly, A remarkably divided and beautifully diversified stream, 20 miles wide, running among innumerable islands from Embomma to Chimquesa, comprehending a distance of 40 miles. And, 3dly, A united stream again, formed of all those scattered streams 40 miles long, and gradually increasing from 3 miles to 6 miles, between Chimquesa and the sea. Now, it is at the mouth of the highest of these united streams, and before it divides among the innumerable islands, that Leyland's and Molyneux's Islands are situated: in other words, they are the two uppermost of these islands, which stand directly in the mouth of the stream from above, and consequently command the whole of the communication which *may be carried on with the interior.*

Are they brought by land or water? 3d, If by water, in what sort of canoes; and if by land, in what manner? on foot, on horses or asses? 4th, What do you suppose may be the direct distance between the sea and the first cataract? Did you hear of any more cataracts, or of any rivers falling into the Congo? 5th, Is there any tradition of canoes resembling those of the Niger, or, in fact, of any thing peculiar to North Africa having come down the Congo with the flood? 6th, Have the Mahomedan priests or Marabouts ever visited that country? Did the natives at Embomma ever speak of any people, except Europeans, that could write? 8th, Is there much diversity in the languages spoken by the people of Congo; and which is the most general language? Do you recollect the following words in that language? fire,—water,—victuals,—drink,—hunger,—thirst,—fatigue,—danger,—a town,—a house,—a city,—a road,—a country? what are their common salutations at meeting? and have they any name for God, or the devil? 9th, Is there any permanent European establishment in the Congo, and do vessels visit it every year, and at what seasons? 10th, Which is the nearest European settlement to the mouth of the Congo, from which a person might at all times find a ready passage to Europe? I hope, My Dear Sir, you will excuse the liberty I have thus taken, and believe me to be," &c.

Mr Maxwell was too anxious about Mr Park's success to keep him long in suspense respecting these particulars; and therefore, on the 12th of the same month he transmitted the following answers.

1st, The principal inland kingdoms that furnish slaves for the Embomma market, are Congo, Mayumba, Mandingo and Yacka. It will be seen by the chart where Congo begins. Indeed, it extends to the south entrance of the river, as Sonio once formed a part of it: and Mayumba, from what Mr Maxwell could learn, is a woody country, bordering upon the river, about 15 or 20 days journey to the N. E. of Embomma. One of its traders brought him a stalk of sugar cane 14 feet long and 2 inches diameter, saying that it was very abundant with them. Mandingo and Yacka, (probably the Mayacka of the charts,) lie at a much greater distance, and most likely on the east side of the river; for, though the Loango people can converse with them, their language differs very materially from the rest. The Mandingos have nine cuts on each cheek, as shewn in the annexed sketch, and are reproached with eating their prisoners, and the flesh of bats; customs held in the utmost abhorrence and detestation by the other nations, who are all remarkably humane and hospitable, except the Sonios, who received repeated injuries and provocations from the Portuguese, when they attempted a settlement among them about seventy years ago.



Sketched by Mr Maxwell.

To Mr Park's 2d query he replied, that the slaves are all travelled by land, carrying their provisions, consisting of dried plantains, cassava, Indian corn, ground nuts, smoked fish, &c. along with them; except the Congos, who bring them in canoes part of the way. On the 3d he remarks, that their canoes are generally very small, and round-sided, being ill adapted for burden, or navigation of any kind, some of them carrying twenty people, but seldom more than seven or eight, who are obliged to sit down on the very bottom of the canoe, with their legs stretched out, and their fore-arms and hands lying along the gunwale, to keep it as steady as possible, to prevent it from oversetting, which, with all their care, frequently does happen: That they commonly use two paddles, seldom more than four; and the canoe-boys, as they are called, stand upright to paddle, which has a very awkward appearance. They have neither horses, cows, nor asses; their only domestic animals being sheep, goats, and poultry, which may be got at reasonable prices. They have also a species of jackal domesticated, but very ugly, and of little use as a dog. On the 4th query, as to the cataracts, they informed Mr Maxwell of two; the first distant from the sea, as laid down in the chart of the river; the other ten or eleven leagues higher up, which has a sloping fall of 30 feet. The river in that place is of its ordinary breadth, and makes a most tremendous noise; but the first has only the appearance of breakers. They spoke with assurance, that no rivers join the Congo for a great way up; yet, were it not for one circumstance, Mr Maxwell would be almost certain that it received a very considerable branch from the S. E. being the only way to account for the great increase of the river in December and January; only in that course, it would cross the route of the Portuguese traders from Loando St Paul's, and their other settlements, which, in his opinion, would have led them to fortify the mouth of the river twenty years ago, instead of Cabenda, forty miles to the northward of it, when the French sent out a couple of frigates, with 300 troops, and demolished the fort *. In answer to the 5th query, Mr Maxwell says, that he never heard them speak of having seen any canoe, or other substance floating down the river, but such as were quite familiar to them; although it is probable that such an event may have occurred in the lapse of time. The only thing that makes against the supposition is, that any bulky substance would most likely have been seen by some of the numerous inhabitants along each shore above the cataracts, who would instantly have launched their canoes and brought it to land: but should it have escaped the observation of those above the falls, it would have been infallibly dashed to pieces at the cataracts; after which, its fragments would háve become water soaked, and rendered incapable of appearing above the surface of a rapid running stream, at all times of a brick colour. A stranger who visits the Congo, says Mr Maxwell, in the latter end of September, when there is least water, would never doubt but the river was then in full flood, until he examined the perpendicular rocks of Taddi-lem-Weenga, when he would observe a watermark of from 9 to 12 feet above its surface.

On the 6th query, he says, That he never heard them speak of any Mahomedan priests having visited that country, though he confesses, supposing the Congo to be the outlet of the Niger,

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* Mr Maxwell has si [illegible] by a friend, that a branch of the Congo does take a sharp turn to [illegible] nbeenda, and that this branch runs past the walls of the Por [illegible] ommonly known by the name of St Salvador or Banza Congo.

it seems strange that none of those fanatics had ever followed the course of the stream: unless some vigorous Negro power bordering on Wangara may have hitherto prevented their entering South Africa: whilst distance alone would deter the merchant, by leading him out of the established line of traffic, and exposing him to incalculable hardships and expence. Neither do they recollect, as he remarks on the 7th query, of any people having ever appeared in that part of Africa that could write, except the Portuguese, who have a very large establishment at Banza Congo or St Salvador, about 4 days journey, or 100 miles (as they say) to the S. E. from Embomma; where they have a great many churches and monasteries; from which place, to 14° south, the country is completely under the trammels of the Catholic religion; but they have never made their appearance at Embomma, or Mambeenda, 50 miles higher up, where the natives are all Pagans. Nor did any of them remember to have heard that any white person was ever seen there, until Mr Maxwell went up. With respect to the 8th query, he says, That there is very little diversity in the language spoken between Cape Lopez in 0° 30′ South, and Benguela Nova in 12° 30′ south, as he could understand a little of it at both these extremes. The Loango and Mayumba idioms, however, are the most prevalent, and the Congo and Angola differ not so much from these, as many of the counties of England do from each other. The customary salutations, on meeting are; one kneels on his left knee, and gives the saccula, (a certain clapping of the hands,) saying, " Katto-co-keile,"—" How do you do?" to which the other, in the same manner, returns the compliment, by saying, " Keile-ma-botta-moine,"—" Very well, thank you, Sir." They call God, Enzambi Empoongu; the devil, Empollo Enzambi; fire, Embazzu; lightning, Loosaimo; thunder, Emvoola boomina; rain, Emvoola; a cloud, Toota le emvoola; the rainbow, Chaama; dew, Blola; wind, Empaimo; a snake, Nyouca; the Boa Constrictor, Bomma;—from whence Mr Maxwell supposes Embomma to have got its name, as they are very plentiful there; the alligator, Engando; the hippopotamus, Engoovu; hunger, Enzalla; a house, Unzo; a town, Bealla; a city, Banza; a country, Incee. " From what country?—Incee wa tooka?" " From Congo,—Moose Congo."

"From Yacka, Moose Yacka." On the 9th query he says, There are no European factories in the Congo, but vessels may be found lying there at all seasons of the year. And on the 10th query he mentions, that the nearest European settlement to the mouth of the Congo is Loando St Paul's, a large city in 8° 55′ south latitude, the roadstead of which is sheltered by a low sandy island, and strongly fortified; but they have very little intercourse with Portugal, their trade being chiefly with the Brazils. Neither would a traveller from the interior of Africa, in his opinion, find himself comfortable with them, being a colony of convicts, little better than the Giagas, and extremely jealous of other nations gaining any knowledge of that country. They have also a detached fort, Nova Redonda, in 11° 8′ south latitude, and Benzuela Nova in 12° 30′ south latitude, protected by a fort mounting 30 pieces of cannon, but most of the carriages are unfit for use. At all which places on the sea-coast, they have vast herds of cattle, and supply ships on very moderate terms; a large bullock being only 15s. or 20s. These two last, with Banza Congo, are dependent on Loando St Paul's, and from these they have numerous factories, branched out hundreds of miles to the eastward.

Such were the answers which Mr Maxwell sent to the queries of Mr Park; but he did not stop there; for, considering it of importance to make Mr Park acquainted with the best method of ascending the river, he stated to him the plan which he himself had intended to adopt had circumstances admitted; and this plan is so simple and natural, that I shall give it to the reader nearly in his own words.

His scheme was to have carried out six supernumerary boats of light construction, to row and sail fast, and to have called at Cabenda, before entering the river, to have engaged thirty-six black rowers, which could have been hired at the rate of 2s. or 2s. 6d. *per* week, which would have saved the white people from the fatigue of rowing, and exposure to sun and rain, the chief cause of all the mortality on the coast of Africa. They would at the same time have served him for linguists a great way up, and when they bega[illegible]h, he would then have engaged another to act a[illegible]hem, and so on successively as he went along, wi[illegible]enabled him to keep up an understanding with the different nations he visited. In this way, he would have had five whites and six blacks to each boat, which would have ſurniſhed him with a ſufficient power to carry the whole of them over the acclivity of any cataract he was likely to meet with, in one day. Each boat, of course, must have been of such burden, that, when the lading was taken out, and turned bottom upwards, ten or twelve people might readily have carried it in slings or bearers; and it was to have been fitted with light masts and sails, and tarred awnings to reach fore and aft, and stretched to iron stanchions four feet above the gunwales, to keep off the sun and rain when rowing; having side or drop cloths, also tarred, to unfurl and tie tight down to the boat's side, to exclude the dews and night air when the boat's crews were asleep; and when a breeze of wind sprung up, these awnings and drop cloths could have been furled and the sails set. The boats were also to have been built so as to pull eight oars occasionally, that, when the wind failed, they might row close with the shore, by which means he expected to have made 35 miles *per* day upon an average; for he could not suppose that the stream runs equally strong above the uppermost falls, where the country must be more upon a level, as it does in the lower part. In this manner he would have continued ascending the river 40 or 50 days, if it proved of such extent, and would have taken half that time in returning to Embomma, making 75 days in all, in which time the ship would have made her purchase, and been ready for sea. Being a mountainous country, it is highly probable that valuable stones and minerals may have, for ages past, been washed out by the rains. He would therefore have carried out specimens of metals, ores, minerals, &c. to have shewn the natives as he went along, that if any such thing could be found in the beds of torrents, they might collect them before his return. Now, though this adventure would have been conducted in the most friendly and conciliating manner, yet there is no saying how far the jealousy of the natives might have been excited by such a novel appearance; and though he did not apprehend that such would have been the case, yet it would have been very prudent and highly requisite to have had it in his power to defend himself, and especially to secure his descent over the different falls, should the natives, at any of those places, have attempted to prevent his return: for which purpose, each boat would have been mounted with 6 small swivel guns, a couple of which from each boat might have been mounted on spare stocks driven into the ground, on some commanding situation at the carrying place, to protect the party during that operation; and by having all the gang-casks, chests and packages, made to stow to the best advantage, and marked and numbered for each boat, would have prevented any delay or confusion at the cataracts. With this scheme in view, he would have laid his account to be in the Congo by the end of May, to ascend the river while the sea breezes were strong, and reached far inland, and while the current was only at 5 miles *per* hour; because during the rainy months there is much of calm weather, and the stream running 6 and 7 miles *per* hour, which would render the navigation very tedious.

(*To be continued.*)

Art. XX.—*Notice of a Collection of Rare Plants from India, presented to the Botanic Garden of Edinburgh, by Dr Wallich of Calcutta and Lieutenant-Colonel Udney Yule, C. B. with remarks on the best method of introducing Tropical Species into Europe.* By John Yule, M.D. F.R.S. Ed. and M. W. S.

The most remarkable circumstance observable on the arrival of these plants at Edinburgh, was their general healthy state, and the great proportion of them alive, after a voyage generally so inimical to plants accustomed to a tropical climate. Colonel Yule, who brought them home, attributes this chiefly to the liberal attention and care of Captain Havard of the Honourable Company's naval service, who directed the most careful treatment of them by judicious watering, and covering the case with an awning, to protect the plants from the scorching sun, and equally destructive rains during the passage. This collection originally co [illegible] ut fifty species, and although several of them be [illegible] but little capable of enduring extremes, eith [illegible] e or dryness, yet nearly one half of them, inclu [illegible] se seeds had germinated towards the end of the voyage, were alive and healthy; and had it not been for the late period of the season, at the time of their arrival towards the middle of October, nearly the whole might have survived the winter. Several of those that died, owed their fate to an accidental injury from the spray of sea-water, owing to the inattention of some boys. Among these we have to regret a nondescript species of Rosa from Almara, two new species of Jasminum—lancifolium and—laurifolium. Three species of Ficus,—quercifolia,—virgata and—elastica; Quercus turbinata, Taxus chinensis, (Roxb.) and Tectona grandis. To these are to be added certain Orchideæ, viz. Gomphostylis candida, and—præcox, (Wallich) (Epidendrum, Smith), and Aërides guttatum? A new Cypripedium, viz. venustum, (Wal.) characterised by Mr Brown, and figured in the Botanical Magazine for February last, a Napaul species of this great family is however at present alive, and it is to be hoped will afford offsets, and thus continue its race. This species, which like the C. humile is acaulous, has clearly, in the present instance, suffered from exposure to a temperature in the stove too high for plants, whose geographical range is so elevated as the territory of Napaul. The Orchideæ of the Northern Hemisphere hitherto described, including Cypripedium, Orchis, Ophrys, and Epipactis, have seldom been found beyond it; and their number, so far as we yet know, is extremely limited, when compared with the Tropical species; but the existence of a new Cypripedium towards the base of the Thibet Mountains, leads one to expect other plants, likely to occur under a similar elevation, still more to the southward and eastward. What an extensive field for the naturalist is now opened by our uninterrupted intercourse with every quarter of India,—Ομεν θεριςμος πολυς οι δε εργτοι ολιγοι! Much, however, has been lately done by the well directed zeal of the Marquis of Hastings, whose patronage of the Natural Sciences in general, is already amply manifested.

Among the plants which arrived in the above collection, the following are healthy, and likely to do well:

Panax digitatum.
—— fragrans.
—— fruticosum.
Beobotrys ramentacea.
Guarea vinetifera.
Aristolochia saccata.
Stylocarpus umbellata.
Peliosanthus seta.
Limonia scandens.
Dracæna spicata.
Callicarpa lanceolata.
Sapindus detergens, &c. &c.

As the introduction and naturalisation of useful and ornamental plants is an important object of public economy, the best means of success forms a question of corresponding interest; especially as it is stated in a late paper, in the Memoirs of the Horticultural Society of London, that, of the plants sent from China by a person residing in that country for this purpose, the proportion of those that survive the passage home is on the average about one in 1000 only.

M. Thouin of the Institute of France, first proposed, with this view, sowing the respective seeds in layers, alternating with about an inch of earth between them, from the bottom to the top of boxes fifteen inches deep, and of a convenient size: and in this way, he informs us that he has obtained a great number of foreign plants in a healthy condition; but that the uppermost layers, germinating early on the voyage, generally died *. In Dr Wallich's present experiment, the same inconvenience occurred. Those seeds only in the undermost part of the case were fresh and unaltered, and germinating towards the end of the voyage, remained healthy on their arrival here.

On the whole, from these and similar results, the most probable means of success may be deduced.

1. Repeated disappointment has convinced us, that seeds sent home in the usual way generally perish, losing their germinating property, from various causes, which it is scarcely possible to obviate under the present management. They become either mouldy from being excluded from the free atmosphere, when insufficiently dried, or, if exposed to a very high temperature, they are entirely exsiccated, and the germ, thus deprived of its native moisture, necessarily perishes. The seeds of many tribes being preserved fresh, by the structure of their husks, and the pulp of their fruits, the necessity of preserving these in a sound state, is clearly pointed out by Nature herself, instead of the common practice of extracting the seeds and imperfectly drying them previous to sending them to Europe.

2. When we cannot succeed in preserving seeds fresh in their original envelopes, and when they belong to tribes whose seeds are comparatively naked, it may be presumed in general, that these are inten [illegible] e for speedy reproduction; and, in fact, it is dif [illegible] ve such seeds sound even under their native cli [illegible] nore so, during a distant

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* *Annales du Museum d* [illegible] 2. p. 84.

voyage, and under innumerable adverse circumstances. It is in the preservation of these, then, that we most frequently fail. Here, however, accident, the real author of many important facts in science, would seem to point out the truth. Many seeds, buried under ground for the greater part of a century, have remained fresh and healthy, and have germinated with vigour on being restored to the surface. Why should we not apply this to the present object? In the present experiment of Dr Wallich, and in those of M. Thouin, the seeds sown near the surface germinating early, uniformly were etiolated, and the plants died: but in both, those that were excluded from the agents necessary to germination, remained sound, and sprang up vigorously on being restored to their influence.

3. Instead, then, of the smaller boxes used in these instances, let large casks, or, for the convenience of packing, square boxes of several feet in diameter, be filled with layers of about an inch of fresh mould (free from worms and the larvæ of insects,) alternating with the respective seeds, within ten inches of the surface; the bottom of the boxes being perforated, and several inches of pebbles placed upon it. I have observed that sand, especially that which contains calcareous and ferruginous particles, is less adapted to the preservation of seeds, from its being disposed to concrete, and thus rendering them mouldy.

4. The surface of the boxes should be planted with such rare species as may be supposed capable of encountering the voyage with the greatest probability of success; as the proper treatment, and especially the watering of these, will tend to preserve the seeds below from total exsiccation during the passage.

ART. XXI.—*Account of Three New Species of Lead-Ore found at Leadhills.* By H. J. BROOKE, Esq. F.R.S. Lond. M.G.S. &c. &c. Communicated by the Author.

AMONG some specimens of lead-ore from Leadhills, I have found three new species, of which two have been noticed by Count Bournon, and one by Mr Sowerby. I shall designate them by the names of

Sulphato-carbonate of lead.
Sulphato-tri-carbonate of lead.
Cupreous sulphato-carbonate of lead.

Count Bournon has described the first merely as a variety of carbonate of lead. The second he calls rhomboidal carbonate, and describes it as dissolving more readily in nitric acid, and with greater effervescence than common carbonate. Its primary form, he supposes to be a rhomboid of 60° and 120°. The third species has been called by Mr Sowerby, in his British Mineralogy, Green Carbonate of Copper.

The difference between the external characters of this third species and green carbonate of copper, and between that of the two first species and any carbonate of lead I had seen, induced me to dissolve some of the rhomboidal crystals in nitric acid. The effervescence was considerable, as described by Count Bournon; but I was surprised to observe, after the effervescence had ceased, a white insoluble residuum, which, on examination, proved to be sulphate of lead.

In consequence of the observation of this fact, and of the association generally on the same specimen of the three varieties, or some two of them, I have examined them all, and I believe the following results will be found correct:

The *Sulphato-carbonate* consists of 1 atom sulphate } of lead.
1 —— carbonate }

Effervescence, while dissolving in nitric acid, scarcely perceptible.

Specific gravity, 6.8 to 7.

Hardness nearly as sulphato-tri-carbonate.

Colour whitish, bluish, and greenish-grey, sometimes approaching to apple-green. The crystals I have seen are seldom distinct, always minute, and aggregated together lengthwise, presenting a character approaching to fibrous.

From the measurements taken by the reflective goniometer on two cleavages; from the character of some of its secondary planes; and from the observation of its cleaving more readily in one particular direction than in any other, I conceive its primary form to be a right prism, whose base is an oblique-angled parallelogram of 59° 15′ and 120° 45′. But the crystals I have, are o imperfect to deter [illegible] int with precision, or to give e height of the pris [illegible]

The *Sulphato-tri-C* [illegible] of
1 a [illegible] f lead.
3 — [illegible]

Specific gravity, 6.3 to 6.5.

Hardness between sulphate of lead and cupreous sulphato-carbonate.

Colour of the rhomboidal crystals pale greenish, or yellowish, or brownish, or colourless and transparent, when very minute. The prismatic varieties are colourless, or of various shades of pale yellow. The rhomboids are acute, measuring 72° 30′ and 107° 30′; and from not having found any other cleavage than one perpendicular to the axis of the crystal, I am induced to adopt this as the primary form.

The principal modifications I have observed, are those which pass into the six-sided prism by the truncation of all the solid angles of the rhomboid, and those which produce more obtuse rhomboids, of which there are three or four. The natural planes of all except the most minute crystals are more or less rounded, and consequently afford imperfect reflections.

The *Cupreous sulphato-Carbonate* appears, from the separate analysis of

3.59 grains, } to consist of 6 atoms sulphate } of lead, } if the carb. of copper be
5. ... 4 —— carbonate } chemically combined,
5. ... 3 —— carbonate of copper, } and not accidental.
1.41 ... }

Specific gravity about 6.4.

Hardness between carbonate of lead and sulphato-tri-carbonate.

Colour blue to dark greenish-blue.

The primary form is a right prism, with either a rectangular or rhombic base. From the indication of joints parallel to all the planes of the latter, and from not having observed any joints parallel to more than four of the planes of the rectangular prism, I consider the right rhombic prism as the primary form. The angles of this prism are 95° and 85°; the planes which give the angle of 95° appear on many of the crystals as a dihedral termination to secondary forms, analogous to some prismatic varieties of sulphate of barytes. The crystals are generally very minute, and appear sometimes in small bunches, radiating from their common point of attachment to the matrix.

Besides the cleavages parallel to its planes, the rhombic prism divides also in the direction of its shortest diagonal, and its height is to the edge of the base as 2 to 1.

The fact that presents itself to our notice here, of so distinct a difference of crystalline form, produced by a change in the proportions only of the elements of the crystallised body, will tend to confirm the intimate relation that subsists between the chemical and crystallographical characters of minerals; and it appears to disprove M. Beudant's conjecture, that only the secondary forms of crystals are affected by a change in the proportions of their constituent chemical elements.

It is remarkable, too, that lead should alone present so many instances of a single base combining at the same time with two acids.

LONDON, 13*th May* 1820.

ART. XXII.—*Account of the Earthquake at Kutch on the* 16*th June* 1819. Drawn up from published and unpublished Letters from India.

THE western coast of India has been visited by an earthquake, which has spread desolation and panic over a great extent of country; and whose destructive effects will be seen and felt for many years to come. This tremendous convulsion of nature was experienced from Bombay to beyond the tropic of Cancer; but the centre of the concussion seems to have been in the province of Kutch, which has severely suffered. In describing this alarming occurrence, we shall select, from a variety of letters which have been received on this subject, the most important particulars.

The first and greatest shock took place on the 16th of June 1819, a few minutes before seven in the evening. The day had been cool and showery; Fahrenheit's thermometer ranging from 81° to 85°. The monsoon had set in mildly, without much violent thunder and lightning; and there was nothing unusual in the state of the atmosphere at that season that could afford any ground for apprehension. The wind, which had been blowing pleasantly towards evening, at the commencement of the concussion fell into a dead calm, and in a moment all was consternation and horror. The wretched inhabitants of Bhooj were seen flying in all directions to escape from their falling habitations. A heavy appalling noise,—the violent undulatory motion of the ground,—the crash of the buildings,—and the dismay and terror which appeared in every countenance, produced a sensation horrible beyond description. The shock lasted from two to three minutes, and during that short period the city of Bhooj was almost levelled with the ground. The walls, from the sandy nature of the stone, were crumbled into dust; nearly all the towers and gateways were demolished; and the houses, which were left standing, were so shattered as to be uninhabitable. The fort, which stands at some distance from the city, is so breached as to be rendered useless as a place of defence. It is calculated that nearly 2000 persons have perished in Bhooj alone. Among the sufferers is the mother of the deposed Rajah, who was buried in the ruins of the palace. The surviving inhabitants were obliged to forsake the city, and encamp outside of the walls on some sandhills. Their situation was truly distressing. Bruised, maimed, and in sorrow, they resorted daily to the city to extricate the mangled remains of wives, children, and relations. In this melancholy labour, they were nearly exhausted by the stench arising from the putrid bodies of their friends, and from the carcases of the cattle, which had perished in great numbers. At the date of the last accounts, between 1000 and 1500 persons had been dug out of the ruins.

The devastation was general throughout Kutch. From Luckput Bunder to Butchao, in every town and village, more or less lives were lost by the falling in of the houses; and in the towns of Mandavie, Moondria, and Anjar, very extensive damage has been sustained. Accounts from Anjar state, that the fort wall was almost completely destroyed, not 100 yards of it remaining in one spot, and guns and towers hurled in one common mass of ruin. Scarcely a fourth part of the town is standing, and the houses that do remain are considerably injured. "In one word," says the writer of the account, "a flourishing population has been reduced in one moment to wretchedness and misery; and I fear we shall have to lament the loss of upwards of 100 people, besides those hurt."

The destruction occasioned by this terrible visitation was not confined to Kutch. From Ahmedabad, the capital of Guzerat, we have the following description: "This city is justly celebrated for its beautiful buildings of stone and other materials, and for the famous shaking minarets, which were admired by every stranger. Alas! the devastation caused by this commotion of the earth is truly lamentable. The proud spires of the great mosque, erected by Sultan Ahmed, which have stood nearly 450 years, have tumbled to the ground, within a few yards of the spot where they once reared their heads! Another mosque of elegant structure, which lies to the left of the road leading to the Shahee Bagh, has shared the same fate. The magnificent towers, forming the grand entrance into the citadel, have been much shaken, and cracked in several places, especially the one in which the flag-staff has been placed. Many private houses have been reduced to ruins; but it is most fortunate, amidst all our disasters, that not a single life has been lost, and but few accidents." We learn from Jelilsheer, that "the earthquake was severely felt in that place, and the loss of lives terrible. The fort and town are reduced to ruins. Many of the people killed were already out of doors, which is usually considered a situation of comparative safety. A marriage was about to be celebrated in a rich man's family, and the casts had assembled from various distant quarters: the shock occurred when they were feasting in the streets, and upwards of 500 of the party were smothered in the ruins of the falling houses."

The effects of this earthquake have indeed been so extensive, that we cannot pretend to enumerate the more minute disasters. We have confined ourselves to the most prominent of them; and we now proceed to give some account of the sensations felt by the individual sufferers during the continuance of the concussions. In the British camp, which was pitched in a plain between the fort and city of Bhooj, the general feeling was an unpleasant giddiness of the head, and sickness of stomach, from the heaving of the ground; and during the time the shock lasted, some sat down instinctively, and others threw themselves on the ground. Those who were on horseback were obliged to dismount, the earth shook so violently that the horses could with difficulty keep their feet; and the riders, when upon the ground, were scarcely able to stand. At Ahmedabad, "all the disagreeable sensatio [illegible] experienced of being tossed in a ship at sea in a swell; [illegible] r was so great, that every moment we expected [illegible] under our feet." One gentleman writing fro [illegible] e earthquake began at twenty minutes past s [illegible] The vibration of the couch I was lying on was [illegible] was glad to get off it: the sions, by the circumstance of a volcano having opened on a hill about thirty miles from Bhooj; and about ten days after the first shock, a loud noise, like the discharge of cannon, was heard at Porebunder. The sound came from the east, and was supposed to indicate the bursting of one or more volcanoes in that direction. Undulations of the earth had formerly been felt in this district, but had never been accompanied with any distressing effects. About two years ago, several of the British officers encamped in the neighbourhood of Bhooj experienced a slight shock; but it was so slight that others of them were not sensible of it. It is to be hoped, however, that none will ever be attended with such a horrible catastrophe as the one we have been describing; for the distress occasioned by it is represented by almost all the writers as beyond their ability to describe.

ART. XXIII.—*Remarks on Professor Hansteen's* "Inquiries concerning the Magnetism of the Earth [*]."

THE properties of magnetism, though interesting in themselves, and presenting an immediate application to the practical purposes of life, have not been investigated with the rapidity or success which might have been expected. From the times of Pliny and Lucretius, by whom the power of the loadstone to attract iron, and to attract or repel another loadstone, is mentioned as a fact well known since the remotest times, above a thousand years elapsed before its polarity was detected, and applied to navigation [†]. Three centuries after the compass came into general use, the *easterly* deviation of the needle was recognised to be, not an accidental error, but a universal property of the instrument; another century was required to discover the *dip*, and the variable quantity of both these observations. Dr Gilbert's work in the year 1600, first pointed out the source of these phenomena, in the magnetic influence of the earth itself; and Halley's theory, which followed at the distance of more than a century, may be regarded as the earliest attempt to connect the various facts together by any thing like a general principle. The four poles of his magnetic *terrella*, situated in the interior of the earth; the motion of this *terrella*, less rapid than that of the shell which enveloped it, and therefore causing the poles to be carried slowly round from east to west, had the merit of affording a simple and beautiful expression for a very complicated class of appearances; and though the hypothesis did not embrace all the circumstances of the case, it shewed the track by which the solution of them was to be obtained. Euler's attempt to explain the variation and dip, by means of *two* magnetic poles, appears to be generally abandoned. The author had studied but an inconsiderable part of the phenomena, and his theory does not at all represent the facts observed in many portions of the globe, concerning which he possessed only defective or erroneous information.

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[*] Untersuchungen über den Magnetismus der Erde, von Christopher Hansteen, Professor der Angewandten Mathematik an der Norwegischen Universität, übersetzt von P. Freschow Hanson, Königl. Norw. Department-vollmachtigen und Landcadetten-Lehrer. Erster Theil: die mechanischen Erscheinungen des Magneten. 4to, pp. 502. Christiania, 1817.

[†] Not only the author, but the date of this invention, seems to lie hid in impenetrable darkness. Guyot de Provins, and other trouvères or troubadours, have been quoted, to shew that it [illegible] Europeans about the middle of the 12th century: some expression [illegible] storian appear to carry it farther back at least fifty years. "Are [illegible] nsteen), "by whom the *Landnamobok* of Iceland, or the acco [illegible] f that island was written, mentions, (Part I. chap. 2. p. 7.), [illegible] on, a renowned *viking*, or pirate, the

That part of the science which regards the mechanical properties of natural and artificial magnets, and which must evidently form the basis of whatever system aims at accounting for the magnetical phenomena of the earth, has not been more

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third discoverer of this island, departed from Rogaland in Norway, to seek Gadarsholm, (Iceland), some time in the year 868. He took three ravens with him, to serve as guides; and in order to consecrate them to this purpose, he offered up a great sacrifice in Smörsund, where his ship lay ready to sail; FOR IN THOSE TIMES SEAMEN HAD NO LOADSTONE IN THE NORTHERN COUNTRIES, *(Paiat pa hofdo hafsiglingarmenn enger Leidarstein i pan pinna á nordorlondum).* In Icelandic, *Leid* signifies region, and on this account the Pole star is named *Leidstjerna;* consequently *Leidarstein* signifies guiding-stone. According to the testimony of Snorro Sturleson, Are Frode was born in the year 1068; therefore his book was probably written about the end of the 11th century, at which time, consequently, the polarity of the magnet must have been known in Norway. From the expression, however, it may be inferred, that they were not acquainted with the compass, but merely suspended the natural magnet by a thread."

speedy in its progress. The *double vortices* of Des Cartes, were as unfortunate here as in astronomy, though altered and moulded with all the mathematical acumen of Euler and Bernoulli. They produced no useful result; and the investigation of this matter may be said to have commenced with Hawksbee's experiments upon the law of magnetic attraction and repulsion, published in the Philosophical Transactions for the year 1712. The discovery of *saturation*, due to the labours of Knight, Du Hamel, Æpinus, and others, formed an important step; but the ratio according to which a magnetic particle attracts or repels another, was not ascertained with any degree of precision, till the task was undertaken by Coulomb, almost in our own times.

The causes of so slow an advancement are easy to discover. The extreme difficulty of finding decisive experiments, has retarded or misled all inquiries directed to discover the nature of magnetic force. And as to the phenomena of terrestrial magnetism,—the long period which the variation, dip, and intensity require to complete their revolution, and present the same succession of appearances; the errors to which observations of this sort are perpetually liable; the small number of such observations; the dispersed state in which all of them must be gathered from voyages, undertaken generally with quite different views, have materially contributed to perpetuate the obscurity that still conceals this department of science.

But the present seems a more auspicious period. So far as regards the nature of magnetic attraction and repulsion, a few of its laws appear to be pointed out with tolerable accuracy: the art of experimenting has received fresh improvements; and attempts at least have been made to bring its results under the dominion of mathematical analysis. As to the magnetism of the earth, not only is the attention of seamen more generally directed to the changes of their compass, but the discoveries of Flinders and others have introduced a degree of correctness hitherto unknown in such inquiries. It is a subject highly deserving our attention; and even if at present the variation of the needle, stationary in mos ts of Europe, seemingly regressive in others, did not watchfulness of naturalists, the science itself, bes ate and valuable application of its discoveries to navigation, promises to develope so many curious relations, and to throw so much light over the secrets of electricity, and the other chemical or mechanical powers of Nature, as to demand investigation, though it were but for its own sake. "The mathematicians of Europe," (says Mr Hansteen, with more truth than taste), "since the times of Newton and Kepler, have all turned their eyes towards the heavens, to follow the planets in their minutest movements and mutual disturbances: it is to be wished, that now for a while they could cast a glance down into the centre of the earth, for there also wonders are to be seen. By the stifled voice of the magnetic needle, the earth proclaims the movements of her interior; and could we rightly interpret the flaming page of the polar light, it would not be less instructive for us. The connection of meteorology with the aurora borealis, and, consequently, with the magnetic forces, is perfectly clear: the similarity between Humboldt's isothermal lines and the lines of the same magnetic dip, is equally remarkable. Who has yet been able to explain the cold of Siberia, Greenland, or Terra del Fuego? Who the strange variations of the polar climate, or Cook's observations upon the different distances to which the solid ice extends from the south pole, in the Pacific and the Atlantic Ocean?

"Perhaps a deeper study of the earth's magnetic force would spread the requisite light over these dark matters. From the English expedition to the North Pole; from the French and Russian circumnavigations of the globe under Freycinet and Kotzebue; from the Asiatic travels of M. Humboldt, new and correct observations are soon to be looked for. If the Governments of powerful nations would thus combine to direct the making of observations, and mathematicians to elaborate them; then probably, in no great length of time, the hitherto inexplicable magnetic appearances of the earth, might be submitted to as sure a calculation as the movements of the heavenly bodies."

Without doubt, our knowledge of magnetism is yet very far from such a consummation; and the intricacy of its laws, viewed in connection with the small extent to which they have hitherto been examined, seems to consign the fulfilment of Mr Hansteen's anticipations to a very distant epoch. In the mean time, however, the path to be followed is clear, and the problem has the peculiar advantage, that every approximation to an accurate solution is immediately available in practice. Under this point of view, the work of Mr Hansteen, just quoted, may be regarded as a considerable acquisition. It was undertaken, we are told, in consequence of a prize-question proposed in 1811, by the Royal Society of Denmark, in these terms: "Is the supposition of one magnetical axis sufficient to account for the magnetical phenomena of the earth, or are two necessary?" And the ideas which the author explains in a memoir, crowned on that occasion, form the ground-work of the present treatise. His attention had been excited to the inquiry some years previously, by the inspection of a terrestrial globe, marked with some delineations pertaining to the subject. In particular, he observed an elliptic figure drawn round the south pole, and designated *regio polaris magnetica;* one of the foci being called *regio fortior;* the other *regio debilior.* As the figure professed to be constructed by Mr Wilcke, from data furnished by the observations of Cook and Fourneaux, this statement led Mr Hansteen to compare the representation with the facts; and the comparison being favourable to Wilcke's accuracy, he was next induced to study the theory of Halley, which he had till then considered quite extravagant. The result of his inquiries was, that Halley's theory, in so far as regards the existence of four poles or of two magnetic axes, is perfectly correct; being different only in the position assigned to these poles, and erroneous in supposing them to arise from an interior moveable globe or *terrella.* The theory of Halley certainly gains a powerful accession of strength from such an auxiliary; and though even under its present shape it should prove in magnetism but like the cycles and epicycles of Ptolemy in astronomy, still it is of no small use to possess an hypothesis, which shall connect by any plausible principle, the phenomena of so complicated and vast a department of knowledge. But whatever become of his theory, Mr Hansteen's book has a more undoubted species of merit. It contains an abundant store of facts relating to the variation, dip, and intensity,—many of them collected from the most obscure and widely separated sources. The task of investigating the elementary laws of magnetic force is at least undertaken. Mr Hansteen displays considerable skill in mathematics, and his work is sprinkled with ingenious and striking, if not always sound ideas, that agreeably relieve the dry details in which it of necessity engages, and induce us to look with some impatience for the appearance of the second part, to be employed in considering the *optical phenomena* connected with terrestrial magnetism. It is matter of regret, however, that the order in which the diversified contents of the present volume are brought forward, is rather apparent than real, and that the language in which they are delivered is not more generally accessible to men of science. Under a compressed form, a translation of the work into French or English might have been an acceptable service. In the brief abstract which we propose to give of it, our attention must be limited to a few of the more prominent objects. Such as wish to become acquainted with the expanded reasonings, and with the facts on which they are founded, will find ample gratification in the work itself.

If ever a knowledge of the magnetical phenomena manifested by the earth is attained, its basis must evidently rest on an accurate investigation of the properties possessed by such magnets as we have it in our power to submit to experiments. The laws by which the attractive and repulsive forces of the loadstone exert themselves, have accordingly long formed a prominent object of research: and though our acquaintance with the figure, magnitude, and forces of the terrestrial magnet is yet in far too imperfect a state to allow the employment of such laws, with complete advantage, in explaining its action; our inquiries into the subject of the variation and dip are naturally preceded by an examination of what has been done in this division of the science. Mr Hansteen's theory, indeed, professes to be the empirical result of a comparison instituted among all such observations as were accessible, and seemed worthy of credit; yet, as the speculative conclusions deduced from them ought to contain at least nothing contradictory to the established properties of natural magnets, and consequently presuppose a knowledge of these properties, we shall begin with his fifth chapter, entitled "Mathematical Theory of the Magnet."

On observing the forces of a natural or artificial magnet to be accumulated at each extremity or pole, and to attract or repel more or less feebly according to circumstances; the question naturally suggests itself, in what ratio is the force distributed among the particles of that substance, or upon what function of the distance does its energy depend? To answer this question, it seems necessary to attend to three things. *First*, According to what law do the individual particles of one magnet attract or repel those of another? Their force evidently follows some inverse ratio of the distance, because the former diminishes, while the latter augments: is that inverse ratio the distance simply, the square, or the cube, or any other power of it? *Secondly*, According to what law is the magnetic force shared among the individual particles lying in the line that joins the poles of the same magnet; in other words, is the magnetic intensity of a particle proportional directly to its distance from the middle point of the axis (where that intensity is nothing), or to the square, the cube, or any other power of its distance? And, *thirdly*, According to what law is the force distributed among the particles of a section perpendicular to the axis or line joining the poles of the same magnet? If these points were fully resolved, the magnetic action, of what sort soever we may conceive it, would be entirely submitted to calculation; and though the estimation of all its varieties would far exceed the actual powers of analysis, the problem being now fairly stated, its complete solution would depend entirely upon the progress of mathematics. Experiment having done its part, the data yielded by it would require to be combined by another instrument.

With regard to the first question, it seems so natural to consider every kind of force as some species of fluid or emanation, and it is so easy to see that every species of emanation will be dense, and therefore effective exactly in the inverse duplicate ratio of its distance from the emanating centre; that this law, universally operative in the case of gravitation, was first resorted to for explaining the attraction of magnets. But on attempting to establish the hypothesis by actual experiment, the obstacles were found sufficient to bring out false or very dubious results. "The great difficulty," Lambert observes *, "met with in this sort of researches, is that when we wish to determine the fundamental laws, [illegible] themselves very simple, it is necesments led him to adopt the same opinion: some even contended that it was not proportional to any power of the distance. And though Mayer, in an unpublished paper read before the Society of Göttingen in 1760, and Lambert a few years later, asserted the inverse square of the distance to be the true expression of this law, their statements seem rather to have proceeded on general and somewhat vague deductions, than on decisive facts; and Coulomb (1786) was the first who established this principle, on grounds at all satisfactory. By means of the simple instrument which he invented, and named the Torsion-balance [*], he was enabled to measure, with great precision, the force necessary to make a magnetic bar, horizontally suspended, deviate by any number of degrees from the position assigned to it. Having by this means verified the discovery of Lambert, that the effect of the terrestrial magnet is proportional to the sine of the angle which its meridian makes with that of the magnet acted upon by it; and having farther ascertained, that a magnetised steel wire, 24 inches long and 1⅓ line in diameter, required 35° of torsion to force it one degree from the magnetic meridian of the earth, he took another wire, of equal dimensions, and the same degree of magnetism, and placing it *vertically* in the magnetic meridian, so that its extremity or pole would have intersected the *homologous* pole of the *horizontal* wire, (had no influence existed between them, or their poles not been homologous), at the distance of an inch from the end of each,—he observed the force of torsion necessary to overcome certain quantities of their mutual repulsion. It was found, that the vertical wire at first repelled the horizontal one 24 degrees; that three circles of torsion, or three complete turns of the micrometer, brought the latter within 17 degrees of the former; and, lastly, that eight circles brought the wires within 12 degrees of each other. Adding to each of these results, the effect of the terrestrial magnet, already estimated at 35° of torsion for each degree of deviation *, Coulomb calculated, that, to keep the magnetised wires within 24 degrees of each other, $24° + 24 \times 35° = 864°$ of torsion were necessary; within 17 degrees of each other, $3 \times 360° + 17° + 17 \times 35° = 1692°$ of torsion were necessary; and within 12 degrees, $8 \times 360° + 12° + 12 \times 35° = 3312°$ of torsion were necessary. At the distances 12, 17 and 24, it appears, therefore, that the forces of repulsion are respectively proportional to 3312, 1692, and 864: had these numbers been 3312, 1650, and 828, the repulsion found by the experiment would have been accurately in the inverse duplicate ratio of the distances. The errors, 42 and 36, are not greater than might be supposed to result from the unavoidable incorrectness of such an experiment. Their existence is however almost sufficiently explained, by considering, that though the portion of each wire submitted to the other's influence was very small, it did not consist of a single particle, as the calculation demands, but of a perceptible space, comprehending other particles besides the one whose action was required; and that the force of these other particles being less oblique, and therefore stronger at greater distances, ought actually to produce an excess similar to that found in the experiment. A result entirely analogous was obtained when the *contrary* poles of the two wires were exposed to each other: and as these facts were confirmed by others, and contradicted by no established principle, Coulomb was warranted in concluding, with considerable certainty, that the attraction or repulsion which exists between two magnetic particles, is always *inversely as the square of the distance:* agreeing thus with the force of electrified substances, with the force of gravity, and with every other force or principle that flows from a centre in straight lines. It must be owned, however, that the result of Coulomb's investigation is not founded on so definite and stable a basis, as to render all doubt unpardonable; and the confirmation which a law of such importance in its consequences gains from Mr Hansteen's examination of the subject, cannot be regarded as superfluous.

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* *Analyse de quelq* [illegible] *sur l'Aiman.*

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[*] It consists merely of a very slender wire, generally of silver or copper, by which the magnetic bar to be operated on is suspended in a horizontal direction. The suspending wire [redacted] h a micrometer, to indicate the number of turns, or the quantity stained. The force is proportional to the arc of torsion.

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* In calculating quantities so small, the arc is substituted for the sine, without sensible error.

Mr Hansteen's mode of experimenting seems to be nearly identical with that followed by Hawksbee and Lambert; but the consequences deduced from his experiments belong entirely to himself. Having assumed (for he does not succeed in proving) that the attraction or repulsion between any two magnetic particles must be directly as the intensity of their force, and inversely as *some* power (t) of their mutual distance; and having, in like manner, assumed that the magnetic intensity of any particle must be proportional to some power (r) of its distance from the centre of the magnet; he easily finds a general expression for the effect which a linear magnet would have upon a magnetic point situated any where in the axis produced. The formula is $F = \int \frac{x^r\,dx}{(a-x)^t} - \int \frac{x^r\,dx}{(a+x)^t}$; where F (multiplied by a constant quantity depending on the degrees of magnetism which the point and the line possess,) represents the force; x, the half axis of the linear magnet; and a the distance of the point from the centre of that linear magnet. By assigning different values in succession to t and r, it is easy to calculate (F) the effect for each of these values, with a given magnet (x), at a given distance (a) from the point to be acted on. It will then appear with which of the values, successively assigned to t and r, the results of experiment agree most completely.

The method by which Mr Hansteen endeavours to find the effect of a linear magnet upon a magnetic particle, is liable, like every such method, to the uncertainty of employing a small needle instead of a point, and a prism instead of a line. It can be shewn, however, that the size of the needle, and the thickness of the prism, have scarcely any perceptible influence in the present case. The experiment proceeds upon the principle of opposing the constant magnetic force of the earth to the force of an artificial magnet. The latter is made to vary, by varying the distance.

"Upon a horizontal table a very delicate compass was placed, so that its needle pointed exactly to 0°; from beneath the centre of this needle, an [illegible] r to its direction, or to the magnetic meridian, a [illegible] s drawn upon the table, and divided into port [illegible] en of them were equal to the half axis of an artificial magnet to be used in the experiment. This magnet was then placed on the line, at different distances from the needle; and the magnitude of the angle, which the needle made with the magnetic meridian, was accurately observed for each distance." As the effect of the terrestrial magnet is measured by a constant quantity, multiplied into the needle's angle of deviation; the tangent of that angle will likewise express the effect of the artificial magnet,—when the distances are such that all the lines drawn from the end of that magnet to the needle may without error be reckoned parallel. On comparing the results of the experiment with those of the calculation, it appears, that the supposition of t being equal to 1 or to 3, entirely disagrees with observation; and that, on the other hand, if we make $t=2$, or suppose that the magnetic force diminishes inversely as the square of the distance, the numbers found by experiment differ very little from those found by calculation. The value of r has less effect on the result. The following Table exhibits the consequences obtained by assigning to r and t the only values which yield quantities in the smallest degree conformable to observation.

Distance in half axes of the magnet.	Increase of the Force.			
	By Observation.	By Calculation.		
		$t=2$ $r=1$	$t=2$ $r=2$	$t=2$ $r=3$
11	1.000	1,000	1,000	1.000
10	1.306	1.334	1.334	1.325
9	1.834	1.835	1.836	1.836
7	3.947	3.938	3.945	3.949
5	11.015	11.072	11.119	11.154
4	22.441	22.245	22.411	22.530

From this coincidence between the hypothesis and the experiment, Mr Hansteen thinks himself entitled to lay it down as a fact, that $t=2$; in other words, that *The attractive or repulsive force with which two magnetic particles affect each other, is always directly as their intensities, and inversely as the square of their mutual distance.* Certainly the data from which this deduction is drawn, do not seem to be much more unexceptionable than those of Coulomb; yet the mutual agreement of the two results, proceeding upon principles so different, tends strongly to confirm the accuracy of both; and we may assert, without hesitation, that the magnetic force varies according to this law very nearly, and probably with absolute exactness.

As to the degree of uncertainty which might arise from the undetermined value of r, it is afterwards proved, that, at considerable distances, this circumstance has almost no effect. The value of r, therefore, or the ratio in which the magnetic force is distributed from the middle point of the axis towards both poles, cannot be derived with any certainty from these experiments. Coulomb's investigation of this *second elementary law*, did not yield a very satisfactory result; and the point cannot yet be considered as entirely determined. From comparing the second with the fourth column of the preceding table, Mr Hansteen seems inclined to think that $r = 2$, or that *the absolute intensity of any magnetic particle situated in the axis, is proportional to the square of its distance from the middle point of that axis.* It must be owned, that this conclusion does not differ very widely from the facts established in the foregoing experiments; yet it seems likely that the function of the distance, which expresses the value of r, may be much more complicated than Mr Hansteen supposes: indeed, the *culminating points* of Van Swinden, which occur in every magnetic bar of great length, shew clearly that the curve denoting the intensities, must cut its axis more than once; and as this cannot happen to any species of parabola, we are forced to conclude, that the absolute force of a given magnetic particle is not proportional to *any power* of its distance from the middle of the axis.

The *third elementary law* of magnetism, or the ratio in which the intensity is distributed among the particles of a section perpendicular to the axis, has not been more accurately fixed than the second. On this head, Mr Hansteen observes: "It is the more difficult to overcome the present obstacle, because, in all probability, the law assumes different modifications according to the different figure [illegible] ection. When the magnet is cylindrical, it seems lik [illegible] particles of the section as lie at the same dista [illegible] ntre or axis of the cylinder, have the same inte [illegible] y section may be represented as consisting of an infinite number of rings, possessed of intensities augmenting from the centre to the outermost circumference. In prismatic magnets, the ratio of the distribution is probably more complicated. It appears to me most likely, that this third elementary law, as well as the second, may be deduced theoretically from the first, which states the mutual action of two particles to be always inversely as the square of their distance. On the other hand, it appears equally certain, that a complete solution of this problem is one of the hardest tasks to which analysis has yet been applied,—a task worthy of a La Place."

It is a fortunate circumstance that both these laws, concerning which our information is still so defective, are limited in their operation to the immediate neighbourhood of the magnet, and produce no considerable effect at a distance. From the first law alone can it be proved, that *the effect of a linear magnet on a magnetic particle is inversely as the* THIRD POWER *of that particle's distance from the middle point of the magnet*, in all cases where the distance is very great. It is also shewn, that, in similar circumstances, *the effect of two linear magnets upon each other, is inversely as the* FOURTH POWER *of their distance.* These propositions help us to understand, how, by confounding the entire effect of the magnet with the effect of a single particle, magnetic attraction has been sometimes reckoned inversely as the cube, sometimes as the fourth power of the distance.—What follows, bears more directly on the subject of terrestrial magnetism, to which it is now time to direct our attention. It is demonstrated, that *the distance from the middle of a magnet being the same, the force opposite the poles, or in the direction of the axis, is double of the force in the magnetic equator.* The two following results are strikingly confirmed in the case of the terrestrial magnet: On the supposition of a globe containing at its centre a magnet infinitely small, *near the magnetic equator, the dip must increase twice as rapidly as the magnetic latitude; near the pole half as rapidly*; and, *the increment of the dip must be equal to the alteration of the latitude, at that part of the globe where the dip* = 54° 44′. It is also of importance to remark, that, *if the earth had only one magnetic axis, whose centre coincides with that of the earth, the lines of equal dip would coincide with the lines of equal intensity.* As this is not by any means the case, with regard to the dip and intensity, the proposition is favourable to Mr Hansteen's opinion of the earth having two axes.

(To be continued.)

Art. XXIV.—*Notice respecting some New Species of Lead-ore from Wanlockhead and Lead Hills.* By David Brewster, LL. D. F. R. S. Lond. & Ed. &c.

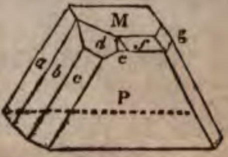
In the month of February 1820, Mr Laing Meason, to whose kindness I had been indebted for various specimens of lead-ores for the purpose of optical analysis, sent me some crystalline fragments of a yellowish-green substance from Wanlockhead. I had found that the *Carbonate* had two axes of double refraction, the principal one of which was parallel to the longer side of the rectangular base of its primitive octohedron. The character of this axis was *negative*, and the inclination of the resultant axes was about 9° 40′. The *Sulphate of lead* had its resultant axes inclined at a much greater angle; and the *Phosphate* and *Molybdate* had only one axis of double refraction.

Upon submitting the substance from Wanlockhead to the same examination, I found that it had two axes of double refraction like the carbonate; that the principal axis had a Negative character, and coincided with the axis of its primitive form; and that the inclination of its resultant axes was a little greater than that of carbonate of lead. These results proved incontestibly that the crystal was neither the *sulphate*, the *phosphate*, nor the *molybdate* of lead, and rendered it probable that it was not the *carbonate*. In comparing it with this last mineral, I found that it was easily scratched by the carbonate; that it had a laminated structure; and that the laminæ could be easily separated from one another by the point of a lancet. When the carbonate was thrown into dilute nitric acid, it effervesced with great violence: crystals of nitrate of le [redacted] speedily formed; and the carbonate entirely disappea he new substance was treated in a similar mann with very much less violence, and left a beau ler, which did not yield crystals of nitrate of lead till at the end of twenty-four hours. Under the action of the blowpipe, it did not decrepitate like the carbonate, and yielded an orange-coloured globule, which is one of the distinctive characters of the murio-carbonate.

The mineral which I have now described, crystallises in hexagonal plates, bevelled on the edges, but imperfectly formed.

The only detached crystal of it which I could examine with the reflective goniometer, is shewn in the annexed sketch.

Incidence of P upon M,	90° 0′
P —— *a*,	90 0
P —— *b*,	110 50
P —— *c*,	127 40
P —— *f*,	110 50
P —— *e*,	125 22
P —— *g*,	120 0
P —— *d*,	120 0
M —— *a*,	120 0



The faces corresponding to *a*, *b*, *c* on the right-hand side of the crystal have the same inclination to *P* as *a*, *b*, *c*.

The crystal cleaves parallel to the face M, and with very great facility parallel to P, the laminæ never being perfectly united, and exhibiting that high lustre which always arises from this cause.

The plane which passes through the two resultant axes, or the centres of the two systems of rings, is parallel to M, and perpendicular to P, and the principal axis of double refraction is *negative*, and at right angles to P, the red ends of the rings being inwards, or nearest the principal axis.

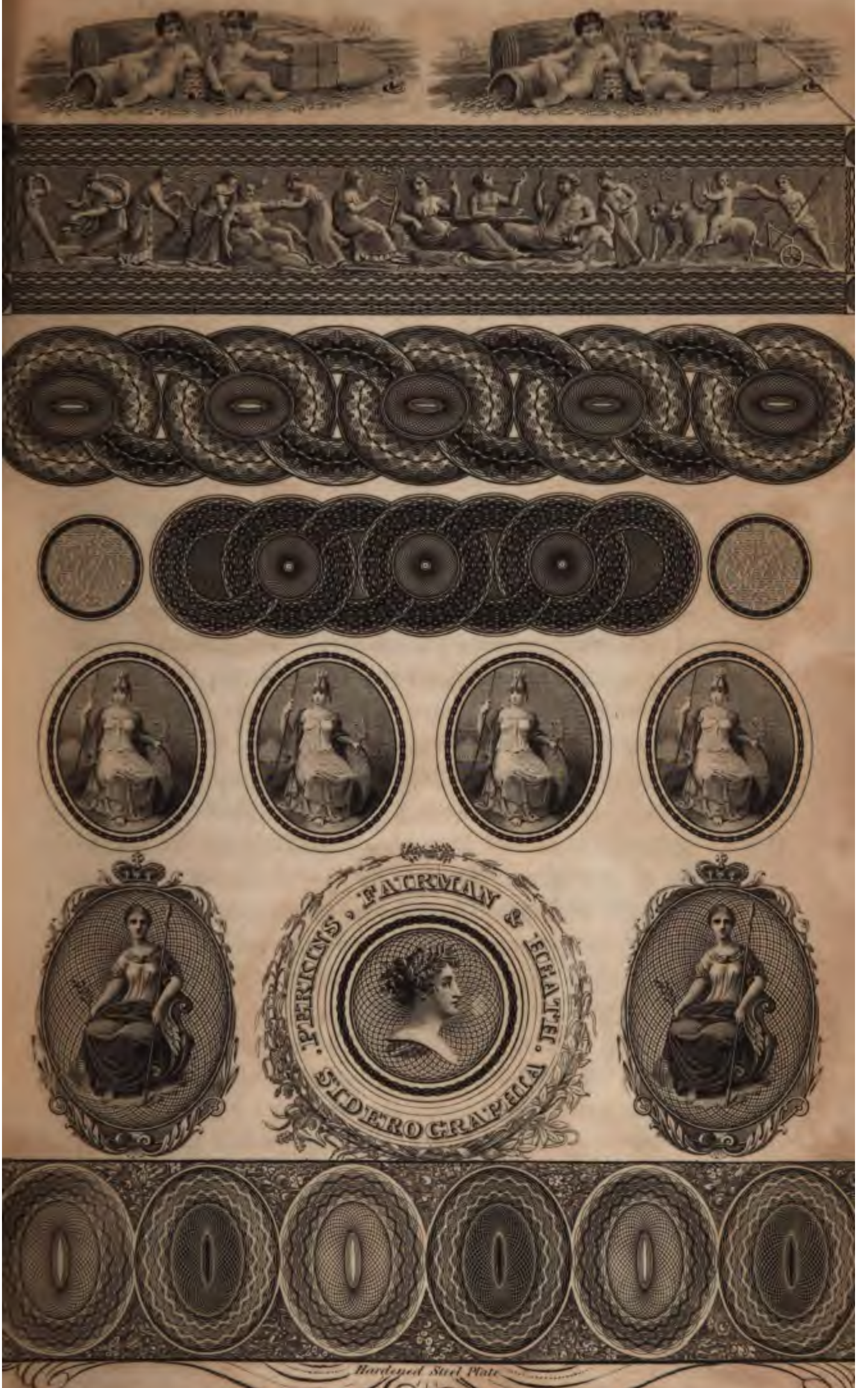
The primitive form appears to be a right prism, having a rhomboidal base, with angles of 120° and 60°. The interior organization of the crystals is still more imperfect than their external form. Different parts of the plate have their axes lying in different directions, and the crystals are sometimes intersected by oppositely crystallised veins, like the specimens of Arragonite which I have represented in the First Number of this Journal.

As the mineral now described was obviously different from all the common ores of lead, I was induced to believe that it was either the murio-carbonate of lead, or an entirely new ore. It resembled the murio-carbonate in the difficult solubility of the white powder, and in the orange button which it yielded with the blowpipe; while it differed from that mineral in its colour, and its crystalline form. The very minute portion of the ore which was in my possession, rendered it impracticable to remove this uncertainty; but in order to ascertain its ingredients as far as possible, I sent all the fragments I could spare to Dr Fyfe, who informed me on the 6th of March, that the difficultly soluble powder appeared to be sulphate of lead, and that the mineral was likely to be a *sulpho-carbonate*, although it was necessary to subject a greater quantity to examination before this could be decidedly ascertained. On the other hand, it is proper to state, that in another specimen belonging to Mr Allan, of the same colour, the same crystalline form, and the same optical properties, Dr Fyfe detected *traces of muriatic acid.*

With the prospect of removing this uncertainty, Mr Laing Meason and Professor Irving had the goodness to promise, that they would endeavour to procure some specimens of this mineral from Wanlockhead and Lead Hills. Professor Irving has succeeded in obtaining a very fine specimen, which he himself examined, and found to be a *sulpho-carbonate*,—a result which has been completely confirmed by Dr Fyfe. This specimen, which he was so good as to present to me, is a sort of geode, from which irregularly crystallised prisms shoot up in various directions. One of these prisms is about an inch and two-tenths long, and several about three quarters of an inch. Their colour is a sort of bluish-grey. Other flat rhomboidal crystals, like those from Wanlockhead, with bevelled edges, occur among the prisms, but their form cannot be easily determined. The surfaces of the prismatic crystals were too irregular to be measured; but I found that they were rectangular, with additional faces, some of which were incident at angles of 120°, and others at 145°, to the adjacent planes.

ART. XXV.—*A Brief Account of Messrs* PERKINS, FAIRMAN *and* HEATH's *Invention for Perpetuating Engravings upon Steel, or other Metals.* With a Plate.

THE present age has perhaps produced a greater number of inventions of real value, and more importance to the civilised



Hardened Steel Plate

world, than any other; and among these, that which is the subject of the present paper, may justly claim the admiration, not only of every lover of the fine arts, but that of every friend to improvement. Whether the subject be considered as it respects the advantages that will result from its application to our manufacturing interest, or with the eye of a philanthropist or statesman, it must be viewed as a most important discovery, which, if carried into effect, cannot fail to put an entire stop to the crime of forgery.

The merit of this invention consists in obtaining, with great facility, from *one* engraving, any required number of plates, all of which are equal to the *original*, and by which millions of impressions may be produced; while, by the common process, one engraving produces only a few thousands. The process of multiplying engravings, etchings, or engine-work, is as follows. Steel blocks or plates, of sufficient size to receive the intended engraving, have their surfaces softened or decarbonated, and thereby rendered a better material for receiving all kinds of work than even copper itself. After the intended engraving has been executed upon the block, it is then hardened with great care by a new process, which prevents injury to the most delicate work. A cylinder of steel, previously softened, is then placed in the transferring press, and repeatedly passed over the engraved block, by which the engraving is transferred *in relief* to the periphery of the cylinder; the press having a vibrating motion equalling that of the cylinder upon its periphery, by which new surfaces of the cylinder are presented, equal to the extent of the engraving. This cylinder is then hardened, and is employed to indent copper or steel plates, with engravings *identically* the same with that upon the *original* block; and this may be repeated *ad infinitum*, as the original engraving will remain, from which other cylinders may be impressed, if required. This invention promises to be of great advantage to some of our manufactures, particularly that of pottery, which may now be embellished with beautiful engravings, so as to place the successful competition of other nations at a great distance. It may also be applied with great advantage to calico-printing, by producing entire new patterns upon the cylinders from which they are printed,—an object of great importance to our manufacturing interest. It may also be applied to produce highly finished engravings for all standard books; and as a means of improving the taste of the rising generation, school-books may be embellished with the best specimens of art, in place of the more humble wood cuts that now adorn them.

Engravings of greater size than can be transferred, are executed upon steel-plates, which, when hardened, will print 200,000 perfect impressions.

One of the great advantages of this admirable invention, is the means which it affords of preventing the forgery of bank-notes. In order to ascertain its utility in this respect, a number of eminent engineers, artists, and men of science, have, at the request of Messrs Perkins, Fairman and Heath, entered into a minute investigation of the principles on which their plan is founded, and have carefully examined the machinery and apparatus by which it is carried into effect. The result of this inquiry has been the most ample conviction of its pre-eminent utility in counteracting the increasing crime of forgery; and the reasons upon which this opinion is founded are given in a report, to which we observe the signatures of Mr Brunel, Mr Maudslay, Mr Donkin, Mr Bramah, Mr G. Rennie, and other eminent individuals.

The impossibility of forging Bank Notes engraved by the method above described, will be readily acknowledged by any person who examines narrowly the accompanying Plate.

Description of Plate VII [*].

This Plate contains fifteen figures, which we may conceive numbered from 1 to 15, as they stand on the Plate.

Fig. 1. and 2. are the same subject repeated, for the purpose of shewing that they are not copies of each other, but fac similes taken by a reverse impression made upon the copper from the same steel cylinder.

Fig. 3. is a very delicate line engraving, we believe, by Heath.

Fig. 4. and 6. The rectilineal border round Fig. 3.; and the whole of Figs. 4. and 6. are scroll or engine work, done by a peculiarly con[illegible] machine. It will be seen from Fig. 4. that in th[illegible] the lines which are black in the one are white [illegible] effect similar to copper-plate and letter-p[illegible]ed.

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[*] The number of this P[illegible] causes, is not engraved upon it.

Fig. 5. and 7. contain the Creed and Lord's Prayer, engraved by B. Davies.

Fig. 8.—11. are fac similes of Britannia from the same steel cylinder.

Fig. 12, 13, and 14. shew how the line engraving may be combined with the engine-work.

Fig. 15. Is a splendid specimen of the engine-work; the 1st, 3d, and 5th oval, representing copperplate engraving, and the 2d, 4th and 6th, block or type printing; all the spaces that are white in the former being black in the latter, and *vice versa.*

Sir William Congreve, we understand, has employed an artist of the first talents to attempt an imitation of some of the preceding specimens. It has been considered by most persons as a total failure, particularly in the small writing and engine-work; though Sir William is of a contrary opinion, and has published a pamphlet, with the view of impressing this opinion on the public.

ART. XXVI.—*Some Observations on the Instinct and Operations of Bees, with a Description and Figure of a Glazed Bee-Hive.* In a Letter from the Reverend WILLIAM DUNBAR, Minister of Applegarth, to the Very Reverend PRINCIPAL BAIRD.

AGREEABLY to your request, I send you the few observations I made last summer on the instinct and operations of my bees. I attach but little value to them, as they are all of minor moment, and shrink into nothing compared with the astonishing discoveries of Huber. Unimportant, however, as they are, comparatively speaking, they add something to the general stock of our knowledge respecting these interesting insects; and they strengthen, in a certain degree, the evidences adduced by Huber of their wonderful instinct in more important operations. They were made by means of a hive containing only one comb, and glazed on each side; the whole swarm, therefore, half on each side of the comb, was exposed to my view; not a single bee could escape my notice, nor could even Majesty itself be secure from my observation. This unicomb-hive was set to work only last summer, and its ill-fated inhabitants perished in the intense cold of the 1st of January,—facts which will account for the observations being confined to what passed during the warm season. I was much disappointed at this catastrophe, as I anticipated no small amusement from observing their operations during spring, the commencement of the laying season,—the period at which the queen lays the eggs of working bees,—of drones,—and of young queens;—the preparations for swarming,—the appearance of the interior of the hive at and after that interesting crisis,—in short, the whole process *ab ovo* till the final emigration of the superfluous population. To repair the misfortune, however, I introduced, on the 25th current, a swarm from another hive into the unicomb; and this morning, the 27th, I had the satisfaction to see her majesty very busy laying the eggs of workers. As the hive contains plenty of honey and farina, stored up during last summer, I have no doubt the breeding will go on rapidly; and I shall perhaps have the pleasure of realising all my former expectations, and of transmitting to you, in the course of the season, observations more worthy of your notice than those I send at present.

Observation 1.—When the bees were put into the unicomb-hive in June last, they of course instantly began building comb. But the narrow limits of their new abode being only one inch and two-thirds between the glasses, prevented any considerable number of them from working at the top. A large portion of them, therefore, began a comb on the stick which crosses the hive in the middle, see Plate VI. Fig. 6. and thus two combs were going on at once, which eventually became one when the upper half reached down to the stick. It appeared, however, that there was still a want of room and of employment for these willing and industrious labourers; for, to my surprise, a portion of them began a comb on the upper side of the cross stick, and, contrary to their natural mode of proceeding, *wrought upwards*; so that in four days or less, the upper comb and this middle piece met, and the whole separate parts were joined, and became one square, see Fig. 7.

2. When the queen is about to lay an egg, she puts her head into a cell, and remains in that position a second or two, to ascertain whether it be fit to receive the deposit. She then withdraws her head, curves her body downwards, inserts her tail into the cell, and having kept this position for a few seconds, turns half round on herself, and, after laying the egg, withdraws her body.

3. When the queen lays a cluster of eggs, to the number of thirty or forty, more or less, on one side of the comb, instead of laying in all the empty cells in the same quarter, she leaves it and goes to the other side, and lays in the cells which are directly opposite to those she has just supplied with eggs, and in none else. In this order she seems to be scrupulously exact, and probably it is to ascertain whether there be an egg in the opposite cell that she keeps her head inserted, previous to laying, longer than would be necessary merely to find whether the one she is inspecting be empty. This mode of proceeding is of a piece with that wise arrangement which runs through all the operations of the bees, and is another effect of that remarkable instinct by which they are guided. For as they cluster closely in those parts of the comb which are filled with brood, in order to hatch them, the heat will penetrate to the other side, and some part of it would be wasted, if the cells on that side were altogether empty, or filled with honey. But when both sides are filled with brood, and covered with live bees, the heat is confined to the spot where it is necessary, and is turned to full account in hatching the young, see Fig. 7. ABC represents that part of the comb which was filled with brood, the rest of the square being all sealed honey. On the opposite side, the brood-comb was exactly of the same shape; insomuch, that on the narrowest inspection, I could not discern one cell where there was brood in the one, and honey in the opposite.

4. The shade round the brood-comb ABC in Fig. 7. is designed to represent cells filled with a mixture of farina and honey for nourishing the young, and which I often saw carried to them by the older bees. Where the brood cells covered a considerable surface, these store-cells were in three rows, as represented in the figure; where they were of less extent, there were two rows; and, at the neck of the figure, only one,—thus preser-

ving a due proportion between the quantity of the food, and the extent of the brood-cells.

5. When a bee arrives loaded with farina, which is now known to constitute the principal ingredient in the food of the young bees while in the maggot state, she searches for a cell in which she may deposit her burden; and, having found one, she fixes her two middle and two hind legs on the edge of it, and, curving her body, seizes the farina with her fore legs, and makes it drop into the cell; after which she instantly hurries away to renew the labours, while another bee inserts her head into the cell and packs it properly, probably mixing, as may be judged from the moist state in which it appears on her retiring, a little honey with it.

6. It was ascertained by Huber, that wax is the produce of the saccharine part of the honey, and that it exudes from the bodies of the bees, between the rings of their bellies, in the form of small thin scales. In confirmation of this fact, I saw one bee, and only one, in the very act of squeezing out thin scales of very pure wax from the rings of her belly. She retreated from my view before I could discern her after-proceedings.

7. I observed the queen at one time hard pressed to get quit of her egg, and not being able to find a cell readily, she dropped it on the edge of one, when half a dozen bees, like so many dogs after a bone, instantly ran to it and devoured it.

8. In the honey months of July and August, when the weather is very fine, the bees form comb intended for containing honey alone, and different from that which is in the first instance destined for brood. The texture of this is much thinner, the cells considerably larger and deeper; and as the honey is then, in the hot season, of a rarer and more fluid quality, these cells are wisely made with a much greater dip or inclination than the ordinary ones, that there may be less risk of the liquid running over before it is sealed.

9. It has been often said, that the queen is attended in her progress through the hive by a number of her subjects, formed in a circle round her, and these have, of course, been called the guards of royalty. The truth is, her majesty has no attendants, strictly speaking, but wherever she moves, the bees she meets with in her progress instantly clear the way for her, and all

turning their heads towards her, fawn upon her, if I may use the expression, lavish their caresses upon her, touching her softly with their antennæ; and this appearance has given rise to the idea that she is attended by guards. The moment she has passed a circle of her admiring subjects, they instantly resume their labours, and she passes on, receiving from every cluster in her way the homage due to a mother and queen.

Such are the few observations I made during the first season my hive was at work. You have the simple facts as they were noticed at the time, without any embellishment; for if they add little of importance to what is already known of the nature and habits of the bee, they owe nothing to the colourings of fancy. If you think them worth sending to the *Edinburgh Philosophical Journal*, you are at perfect liberty to do so; and I hope one good effect of their publication will be, to induce others also to contribute their mite of information. I am myself an enthusiast in the cause; nobody can study them closely without becoming so. "Beaucoup de gens," says a good old clerical bee-master of Switzerland, "aiment les abeilles; je n'ai vu personne qui les aimat mediocrement; on se *passionne* pour elles." Fortunately, I have a reverend brother in my neighbourhood whose enthusiasm equals mine, and whose experience is much greater. I allude to the gentleman whose humane method of saving the lives of these amusing insects has been made honourable mention of in a recent Number of that Journal. If he, and such as he, could be prevailed on to communicate the result of their experience to the public, the natural history of the bee would be better understood, and its cultivation much more profitable.

APPLEGARTH MANSE,
March 27. 1820.

Explanation of Figures 3, 4, 5, *of Plate VI.*

Fig. 3. is the external appearance of the hive, mounted on its stool, and having the shutters closed on the glass; front view.

Fig. 4. is a profile of the same, shewing the edges of the three frames of which the hive is composed, joined on the one side by hinges, on the other by hooks and eyes; the centre one contains the comb, and the outer ones the glass, which is placed one-third of an inch from the inner edge of the frame, to afford a passage for the bees between the comb and the glass. *a a* are two lighting boards to the two entrances, either of which may be opened at pleasure.

Fig. 5. is the stool, fixed upon a square block *a*, and made to turn upon a pivot *b*, which is driven into the ground. The entrances, *c*, are cut, one in each side, in the thickness of the stool, sloping upwards to the floor. When the observer has viewed the bees on one side, and wishes to see the other also, instead of sitting in front where they are busy in coming out and going in, and thus exposing himself to their stings, he has only to shut the front entrance, wheel round the hive on its pivot, and open the other entrance. ***d d*** are two iron rods fixed on the stool, and which support the hive by two staples in the centre frame.

ART. XXVII.—*Historical Account of Discoveries respecting the Double Refraction and Polarisation of Light.* Continued from Vol. ii. p. 171.

PERIOD II. *Containing an Account of Huygens' Theory of Double Refraction.*

HAVING succeeded in explaining, in a very satisfactory manner, the refraction of ordinary transparent bodies, by means of spherical emanations of light, Huygens was naturally led to suppose, that as Iceland spar had two different refractions, it must also have two different emanations of waves of light, one of which might be propagated in a spherical form in the ethereal matter spread through the crystal. He conceives that this ethereal matter exists in greater quantity than the solid particles, and is alone capable of producing transparency. From these spherical undulations, which are propagated more slowly within the crystal than without it, proceed the phenomena of the ordinary refraction. The other set of undulations, to which the irregular refraction is owing, he conceives to be elliptical, or rather spheroidal, and to be propagated indifferently both through the ethereal matter, and through the solid particles. Huygens considers that the regular arrangement of the particles may contribute to the formation of the spheroidal waves, as nothing more is required for this than that the light be propagated more quickly in one direction than another; and he was convinced that such an arrangement actually exists in Iceland spar *.

In proceeding to explain his theory, Huygens supposes AB, Fig. 1. Plate I. (lower part of the plate,) to be the surface of Iceland spar, exposed to a beam of light; and as a perpendicular ray incident upon this surface from a distant luminary, is, by the theory of undulation, no more than the incidence of a parcel of waves parallel to AB, he considers the line BC, parallel and equal to AB, to be a portion of the wave of light, of which the points R, H, *h*, C, meet AB at A, K, *k*, B. Instead of hemispherical waves, as in ordinary refractions, he supposes the waves to be now hemispheroids, whose major semi-axes are oblique to the plane AB. Hence SVT will represent an individual wave coming from the point A, after RC has arrived at AB. Now, as all the other points K, *k*, B, will propagate waves similar to SVT, in the same space of time that the point A did, the common tangent NQ of all these semi-ellipses will be the propagation of the wave RC in the transparent body, according to the above theory.

But the tangent NQ, which is equal and parallel to AB, is not directly opposite to AB, but comprehended between AN and BQ, conjugate diameters to those which are in the line AB. "In this way," says Huygens, "I have been able to conceive what appeared very difficult, how a perpendicular ray could suffer refraction in a transparent body," the wave RC, instead of going straight on when it entered the surface AC, extending itself between the parallels AB and NQ.

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* Huygens considered the existence of two different emanations as rendered more probable by the phenomena of rock-crystal, which he found to possess double refraction; but he has maintained, *that both the refractions are of the usual kind*, and explicable by two spherical undulations, one of which is propagated a little slower than the other. Hence it follows, that he regarded his theory as *applicable only to calcareous spar.*

In order to determine the form and situation of the spheroids in Iceland crystal, Huygens considered, that all the six faces produced the same refraction, which were equally related to the principal sections shewn in Fig. 2. by dotted lines drawn from C. Hence he concluded, that the spheroid which had the same relation to these three sections, must have its axis coincident with the axis of the solid angle C, and therefore that the short diagonal of the rhomb determined the position of the axes of all the spheroidal waves propagated from any point, taken either within or at the surface of the crystal, since all the spheroids ought to be similar, and have their axes parallel.

In the section GCF, the angle C is 109° 3′, and the angle F 70° 57′; and if we conceive a spheroidal wave round the centre C, its axis will be in the same plane. Let CS, Fig. 3. be the half of this axis, then the angle GCS will be found to be 45° 20′. In determining the form of the spheroid, or the ratio of the semi-diameters CS, CP, which are perpendicular to each other, Huygens considers, that the point M, where FH, parallel to CG, touches the ellipse, must be so situated that CM makes an angle of 6° 40′ with the perpendicular CL, being the deviation of the extraordinary ray. Hence we shall have,

$$\begin{aligned} CM &= 100000 \\ CP &= 105032 \\ CS &= 93410 \\ CG &= 98779 \end{aligned}$$

and the ratio of CP to CS that of 9 to 8; the spheroid is therefore produced by the revolution of an ellipse round its lesser diameter.

In order to determine the refraction of oblique rays, Huygens saw that they depended on the proportion between the velocity of the light without and within the crystal; and he supposes this proportion to be such, that while the light in the crystal describes the spheroid GSP Fig. 4., it describes without it a sphere whose semidiameter is equal to the line N, which will be afterwards determined. Now if RC is a ray incident at the surface CK, draw CO perpendicular to RC, and from O draw OK equal to N, and at right angles to CO. Having then drawn KI touching the ellipse GSP, the line IC will be the refracted ray required. For the refraction of RC is nothing else than the progress of the point C of the curve CO, continued in the crystal; but the points HH of this wave, during the time that O comes to K, will arrive at the surface CK by the lines H x, &c. and will also have produced in the crystal particular hemispheroidal waves from the centres x, x, &c. similarly situated with the hemispheroid GSP g; and whose great and small diameters will have the same ratio to the lines $x\,v$ (which are continuations of H x to KB parallel to CO,) as the diameters of the spheroid GSP have to the line CB or N. The common tangent, therefore, of all the spheroids, which are here represented by ellipses, will be the line IK, which will be the propagation of the wave CO; and the point I that of C.

In order to find the point of contact I, we must find a third proportional CD to the lines CK, CG, and having drawn DI parallel to CM, the diameter conjugate to CG, and previously determined, we have only to draw KI, which will touch the ellipse at I.

In like manner we may find the refracted ray C i of any other ray r C, incident on the opposite side, by drawing C o perpendicular to C r, and following the rest of the preceding construction.

Hence we see, that if C r and CR are incident at equal angles, we shall have $\mathrm{C}\,d = \mathrm{CD}$, since $\mathrm{C}\,k = \mathrm{CK}$ and $\mathrm{C}\,g = \mathrm{CG}$. Consequently I i will be bisected in E by CM, to which DI, D i are parallel; and because CM is the conjugate diameter to CG, it follows, that I i will be parallel to g G. If we then prolong the refracted rays CI, C i, till they meet the tangent ML in T and t, the distances MT, M t will also be equal. Hence we see the reason of the phenomena mentioned in vol. II. p. 169. last paragraph.

Huygens next found, by measuring the irregular refraction, that the ratio of N to CG, was that of 156962 to 98779, or of 8 to $5\frac{1}{29}$, and he proceeds to explain an abridged method of finding the irregular refraction.

Let g G, Fig. 5. be the surface of the crystal, GP g the ellipse, and CM the refraction of the perpendicular ray FC, which deviates 6° 40′, and let RC be any other ray whose refraction is required.

From the centre C, and with the semidiameter CG, describe the circumference *g* RG, cutting the ray RC in R, and let fall RV perpendicular to CG. Then, since CD is known from the analogy, N : CG = CV : CD; draw DI parallel to CM, cutting the ellipse *g* MG in I, and joining C and I, CI will be the refracted ray required. For let CO be perpendicular to CR, and OK drawn equal to N, and perpendicular to CO; then if KI touches the ellipse in I, CI must be the refraction of RC. Since RCO is a right angle, the right angled triangles RCV, KCO are similar. Hence CK : KO = RC : CV ; but KO = N, and RC = CG;

Whence CK : N = CG : CV ; but by construction
N : CG = CV : CD; therefore
CK : CG = CG : CD;

and because DI is parallel to CM, the diameter conjugate to CG, it follows that KI touches the ellipse in I.

It appears, therefore, that as there is in ordinary refractions, a constant ratio between the Sines of incidence and refraction, so in the present case there is such a proportion between CV and CD or IE, that is between the Sine of the angle of incidence, and the line intercepted between the refracted ray and the diameter CM; for the ratio of CV to CD is always the same as that of N to the semidiameter CG.

In comparing the regular and irregular refraction, Huygens observes, that if APBS Fig. 6. is the spheroid by which the light propagates itself in the crystal in a certain space of time, and produces the irregular refraction, then the inscribed sphere BVST is the propagation in the same space of time, of the light which serves for the regular refraction. For, since N is the radius of a spherical wave of light in the air, while in the crystal it is propagated by the spheroid ABPS, the ratio of N to CS is that of 156962 to 93410. But the ratio of the regular refraction is that of 5 to 3, that is, N being the radius of a spherical wave of light in air, its propagation in the crystal forms in the same time a sphere whose radius is to N as 3 to 5. But 156962 is to 93410 as 51.3 *minus* [illegible]

Though there are [illegible] propagations of light within the crystal, yet it is [illegible] tion of the perpendiculars the axis BS of the [illegible] e of these propagations is more rapid than the other, for they have the same velocity in another direction, namely, in that of lines parallel to the same axis BS, which is also the axis of the obtuse angle of the crystal.

The ratios of the refractions being such as have now been determined, it follows that a ray of light RC, Fig. 7. incident at an angle of 73° 30′ with CG, should have its refraction CI in the same straight line with RC, or should pass through the crystal without refraction. For since $CG = CR = 98779$; $CM = 100000$, and $RCV = 73^\circ\ 20'$, CV will be 28330. But because CI is the refraction of RC, $CV : CD = 156962 : 98779 = N : CG$, and $CD = 17828$. And since $CG^2 = : CM^2 = GD \times Dg : DI^2$ we have $DI = CE = 98353$. But as $CE : EI = CM : MT$; $MT = 18127$, which being added to $ML = 11609$ (the sine of $LCM = 6^\circ - 40'$) we have $LT = 27936$, which is to $LC = 99324$ as CV is to VR, that is as 29938, the cotangent of RCV, is to the radius. Whence it appears that RCIT is a straight line.

Huygens goes on to shew, that the ray CI emerging at the opposite surface of the crystal, ought to pass straight on without refraction, by demonstrating in general, that the reciprocation of refractions takes place in this crystal as well as with transparent bodies; that is, if a ray RC, Fig. 8., incident on the surface of the crystal CG, is refracted in CI, the ray CI emerging at the opposite and parallel surface IB of the crystal, will have its refraction IA parallel to the ray RC.

Let CO, perpendicular to CR, represent, as formerly, a portion of a wave, whose continuation in the crystal is IK, so that the point C is continued by CI during the time that O arrives in K. If we now take a second space of time equal to the first, the point K of the wave IK will, in this second portion of time, have moved through the right line KB, equal and parallel to CI, because every point of the wave CO, in arriving at the surface CK, ought to continue in the crystal the same as the point C, and in the same time it will propagate from the point I in the air, a spherical wave having a semidiameter $IA = KO$, since KO is described in the same time. If we consider any other point *h* of the wave IK, it will advance by *h m* parallel to CI, and reach the surface IB, while the point K describes $Kl = hm$, and during the time that K has completed the remainder lB, there will have been propagated from the point m, a spherical wave, whose semidiameter mn will have the same ratio to lB as IA : KB. The waves mn and IA will therefore have the same tangent AB, and the same is true of all the other spherical waves that are propagated out of the crystal by the impulsion of all the points of the wave IK against the surface of the ether IB. The tangent BA will therefore be the continuation of the wave IK out of the crystal, when the point K has come to B, and consequently IA, which is the perpendicular to BA, will be the refraction of the ray CI in going out of the crystal. But IA is parallel to RC since IB = CK, and IA = KO and A and O right angles.

Art. XXVIII.—*Outline of* Professor Mohs's *New System of Crystallography and Mineralogy*[*].

1. *Simple and Compound Forms.*—Some crystalline forms consist of faces entirely equal and similar; others are bounded by faces which are not all equal and similar: the former are called *simple*, the latter *compound* forms, or *combinations.*

2. *Regularity of the Combinations.*—Every combination is composed of simple forms, and the junction that takes place among those simple forms, is the *most regular* which their nature admits.

3. *Symmetry and General Problem of Crystallography.*—The regularity of junction among the simple forms of which compound forms are composed, is called the *symmetry* of those combinations. *Crystallography furnishes the mathematical basis on which this symmetry is founded.*

4. *Edges of Combination.*—The edges formed by the meeting of the faces of two different simple forms, are named *edges of combination.* Of this species are the edges between P and *f*, Fig. 4. Plate VIII.

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[*] Communicated by a Pupil of Professor Mohs.—Ed.

Fig. 1.

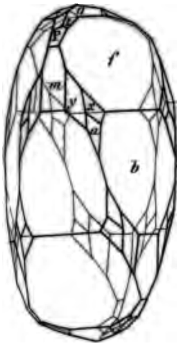


Fig. 2.

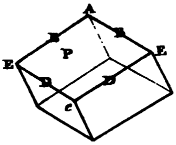


Fig. 3.

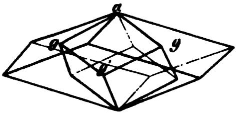


Fig. 4.

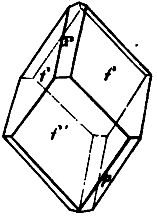


Fig. 5.

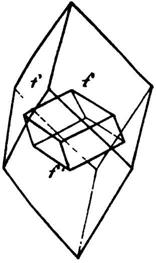


Fig. 6.

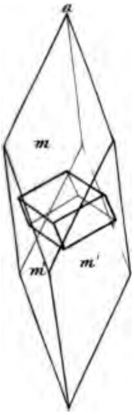


Fig. 7.

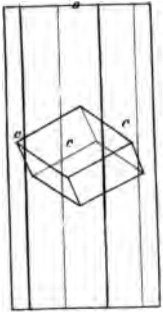


Fig. 8.

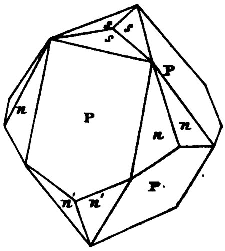


Fig. 9.

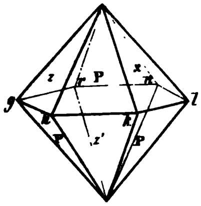


Fig. 10

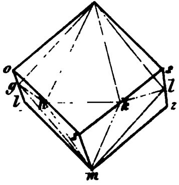


Fig. 11.

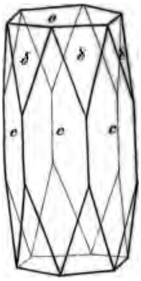


Fig. 12.

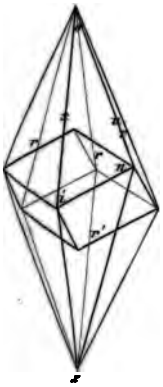


Fig. 13.

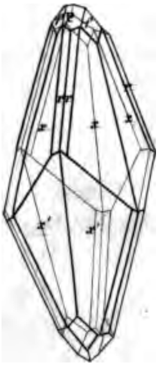


Fig. 14.

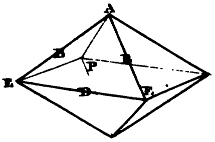
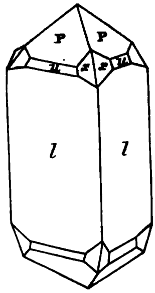


Fig. 15.



W. H. Lizars Sculp^t

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5. *Explanation by example. Problem of Crystallography for a particular case.*—Let Fig. 1. Pl. VIII. represent a crystallisation of calcareous spar. The form is a compound one, and all the faces of the same description belong to the same simple form contained in it. The junction of those simple forms is symmetrical, because it possesses the highest degree of regularity which their nature and position can admit. The symmetry in this case is expressed by the parallelism of the several edges of combination: and the general problem of crystallography is here transformed into the special one, *of finding the circumstances under which the edges of combination obtain their parallelism.*

6. *Preparation for the solution. Developement of the combinations.*—If in any combination the homologous faces (the faces agreeing in figure and position,) are enlarged till all the rest having disappeared, they alone bound the whole solid on every side, the simple forms which the combination included, will successively appear. By this operation, from the faces *g*, P, *f*, *m*, *b*, of Fig. 1., we obtain five rhomboids, (Fig. 3. 2. 5. 6. Pl. VIII.); and from the planes *x*, *y*, *a*, three *scalene six-sided pyramids*,—pyramids consisting of scalene triangles, (as Fig. 12. Pl. VIII.)

7. *Position of the Rhomboids in the Combination.*—The rhomboids have a particular arrangement in the combination, viewed in the distribution presented by this example, the edges of any rhomboid, and the oblique diagonals drawn upon the faces of the one which follows it, lie in the same vertical plane. Such combinations as do not include an uneven number of rhomboids, are arranged, so that the edges of one rhomboid lie in the same vertical plane with the edges of the next, and the diagonals of the one with the diagonals of the next. In Fig. 2, 3, 5. 12. 6. Pl. VIII., taken in the order assigned to them, (6.) this arrangement is observable.

8. *Combination of two rhomboids.*—If the faces of any *two* rhomboids, which stand contiguous in the above mentioned order, *g* and P, for instance, or P and *f*, or *f* and *m*, or *m* and *b* of Fig. 1. Pl. VIII., are simultaneously enlarged, till all the other faces disappear, and the faces of *this pair* include the whole solid; a form results, which is *a combination of those rhomboids*,

and the edges of combination made by its faces with each other *are parallel*, as in Fig. 4. Pl. VIII.

9. *Statement of the foregoing problem, for a combination of two rhomboids.*—This parallelism evidently arises from the dimensions of the rhomboids, in other words, from the magnitude of their angles, because it disappears whenever the dimensions of the one or the other are changed. The foregoing problem, (4. 5.) therefore requires, *to find the ratio of the dimensions by which the edges of combination are rendered parallel.*

10. *Solution. Upright position.*—Place a rhomboid in such a position, that the straight line passing through two corners (solid angles,) formed by equal plane angles, may be vertical. Those corners are named the *summits*, that line the *axis*. In this position the rhomboid stands *upright*. Rhomboids, therefore, stand upright, when their axes are perpendicular.

11. *Horizontal projection.*—From those solid angles of a rhomboid, which are not summits, let fall perpendiculars upon a horizontal plane, and connect the points where they meet the plane by straight lines. The figure which results will be a regular hexagon; it is called the *horizontal projection* of the rhomboid.

12. *Derivation of a more obtuse rhomboid.*—Bring a rhomboid into the upright position; and through those edges which meet in the extremity of the axis, stretch planes equally inclined to the faces of the rhomboid. Extend these planes till they all intersect each other: the solid bounded by them will in its turn be *a rhomboid*, Figs. 2. & 3. Pl. VIII., Fig. 2. the original, Fig. 3. the derived with the original.

13. *The horizontal projection of this four times that of the preceding.*—The axis of this new rhomboid is equal to that of the preceding, (Fig. 3. Pl. VIII.) The horizontal projection is equal in area to *four times*, in periphery to *twice*, the horizontal projection of the latter.

14. *Together, they produce parallel edges of combination.*—This new rhomboid has a position different from that of the first (7). The edges of the former have a similar situation with the oblique diagonals of the latter; that is to say, they lie in the same vertical plane with those diagonals. If sections are drawn parallel to the faces of the new rhomboid, and lying

nearer the axis or middle point; those sections will truncate the edges of the original rhomboid: from which will arise the form of a *combination* of two rhomboids, *having the edges of combination parallel,* and consequently exhibiting the same relation in their dimensions as those two preceding rhomboids (1), according to the order in which they were named, as Fig. 4. Pl. VIII.

15. *Expression of the proportion between the two rhomboids, by means of their axes.*—To give the foregoing proportions a more convenient expression, suppose the horizontal projections of the rhomboids, or the sides of those projections, to be equal, the axis of the new rhomboid (12) will then become equal to *half* the axis of the original rhomboid. It follows, that, *if two rhomboids produce parallel edges of combination with each other, the axis of the one must be half that of the other, the horizontal projections being equal.* This is merely the proportion between the two rhomboids, expressed by their axes, on the supposition of equal horizontal projections. The *absolute dimensions* of the rhomboids must be such, that both together may be capable of contributing to bound the solid.

16. *That proportion universal.*—On each of the rhomboids formed by the foregoing process (12), the same process may again be repeated. A new rhomboid in its turn will result, whose axis, if the horizontal projections are equal, being half the axis of the rhomboid immediately preceding, will consequently be fitted to produce parallel edges of combination with it.

17. *Inversion of the process.*—The process (12.) may be inverted. Draw the diagonals: through every two oblique and one horizontal diagonal, extend cutting planes, and deduct the portions which lie without them. The remainder, the part inclosed within the cutting planes, will likewise be a rhomboid.

18. *Proportions of the new rhomboid.*—The axes of both these rhomboids are equal. The horizontal projection of the new rhomboid is the fourth part of the horizontal projection belonging to the original rhomboid; the sides of the former are equal to half those of the latter: and consequently, when the horizontal projections are considered equal, the axis of the secondary will be *double* that of the original rhomboid.

19. *This proportion is likewise universal.*—This process may be continued indefinitely (16); and of all the rhomboids

that result from it, any two following in immediate succession will always exhibit such mutual proportions, as to produce parallel edges of combination with each other.

20. *Series according to the powers of 2.*—All those rhomboids which are produced by a given operation (that of 12, 17, or both,) are consequently subject to the general law, *that, their horizontal projection being equal, their axes must increase or diminish as the powers of the number 2.* These axes, therefore, follow each other in a geometrical progression, and the rhomboids constitute a series, which may be developed out of any given member, and expanded indefinitely on both sides.

21. *Designation of the series.*—Let the fundamental rhomboid be designated by r; the next more acute one, obtained from the second process (17), by $r+1$, so that this expression may point out the rhomboid's place, or its distance from r; the next more obtuse one, obtained from the first process (12), by $r-1$, so that by this means the distance or the position, with regard to r, may in like manner be expressed; and the rest in a similar mode; then if the axis of r is put $=1$, the first of the three following lines will represent the series of rhomboids, the second their axis, and the third those powers of 2 by which they are expressed.

$$- - - r-3\,.\,r-2\,.\,r-1\,.\,r.\quad r+1\,.\,r+2\,.\,r+3\; - - -$$

$$\tfrac{1}{8}\,.\quad \tfrac{1}{4}\,.\quad \tfrac{1}{2}\,.\; 1.\quad 2\,.\quad 4.\quad 8\,.$$

$$2^{-3}.\quad 2^{-2}.\quad 2^{-1}.\; 2^{-0}.\quad 2^{1}.\quad 2^{3}.\quad 2^{2}.$$

22. *Limits.*—These progressions may be prolonged on both sides as far as we please (16. 19.) The horizontal projections being equal, the axes by this means perpetually augment on the one hand, and perpetually diminish on the other. If they become infinitely small, the rhomboids are converted into *regular six-sided prisms*, the one of which has an axis infinitely great, the other an axis infinitely small. These prisms are named the *limits to the series of rhomboids*; their designation is $r \pm \infty$: and hence within its limits the series is

$$r-\infty\; - - - - -\; r-1\;.\; r.\; r+1 \ldots\ldots - - r+\infty$$

Base of the regular six-sided prism.	Rhomboid whose axis $=1$.	Unlimited regular six-sided prism.

23. *The limits by themselves not in nature.*—Forms of infinite dimensions are not exhibited by nature. The limits appear, therefore, only in combinations. The complete regular six-sided prism, as displayed in nature, is a combination of both limiting forms.

24. *Confirmation by experiment.*—Nature confirms the law of this rhomboidal series within its limits in all minerals that assume such forms. In *calcareous-spar*, of which all the figures in Pl. VIII. are varieties, let P Fig. 2. be represented by r; that is to say, by the rhomboid which constitutes the basis of derivation, and whose axis has been put $=1$; then is $g=r-1$, Fig. 3.; $f=r+1$, Fig. 5.; $m=r+2$, Fig. 6. All these rhomboids have pretty exactly the dimensions which they would have if calculated according to the foregoing proportions from the rhomboid P, estimated $=104° 28'$. If, in place of that number, we employ $105° 5'$, the result of numerous measurements instituted for this purpose, the dimensions of the derived rhomboids calculated upon this supposition agree still more exactly with nature. c (Fig. 7.) Pl. VIII.) is $=r+\infty$ in combination with $o=r-\infty$. Again, in *tourmaline*, let P be $=r$; then is $n=r-1$; $o=r+1$; r (of the figure) $=r+2$; l and $l'=r+\infty$, and $k=r-\infty$. In *chabasie*, let P be $=r$; then is $n=r-1$; r (of the figure) $=r-1$. In *dioptase*, P does not appear as a crystal, but merely as a cleavage form. If P is made $=r$; then is r (of the figure) $=r+1$: s in this species is not $r+\infty$, as what follows (29.) will shew. In *red silver*, let P be $=r$; then is $z=r-1$; $s=r-2$; g or $i=r+1$; k and $o=r+\infty$ and $r-\infty$: n is not $r+\infty$, (29.), but of the same nature with s in dioptase. In *iron-glance*, let P be $=r$; then is $s=r-2$, ($r-1$ and $r+1$ exist in nature, but are not noticed by Haüy). Lastly, in *sulphate of iron*, let P be $=r$; then is r (of the figure) $=r-1$; $o=r+1$; and $n=r-\infty$. Besides these examples, nature affords many other proofs in favour of this series; they are not contained in the figures of the *Traité*; hence $b=r+3$ belongs to our Fig. 1. Plate VIII *.

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* All the figures in the text not referred to in our Plate VIII. are to be found in Haüy's Mineralogy.

25. *Principal and accompanying series.*—In different minerals, particularly in calcareous-spar, several rhomboids appear, which are not included in the preceding series, (20. 23.) They still, however, follow the same general law. We obtain them by multiplying the axis of any term in that series by $\frac{5}{4}$, $\frac{6}{4}$, $\frac{7}{4}$. From this process, three series of rhomboids arise; of which that having $\frac{5}{4}$ for its co-efficient is named the *first*, that having $\frac{6}{4}$ the *second*, and that having $\frac{7}{4}$ the *third accompanying series*, in relation to the original, which is called the *principal series*. The terms of the accompanying series are capable of being found by a deduction similar to that used in the principal series; but the narrowness of our limits will not allow us to exemplify this method. One instance of a single term in an accompanying series is *s*, Fig. 6. Plate xxiii. Haüy.

26. *Isosceles six-sided pyramids.*—Suppose Fig. 8. Pl. VIII. to represent a crystalline form proceeding from iron-glance. If the faces P are enlarged till they comprehend the entire solid, the figure will be changed into a rhomboid. If the faces *n* are enlarged till they likewise completely include the whole solid, we obtain an *isosceles six-sided pyramid*, Fig. 9. Pl. VIII.

27. *Proportions to the rhomboid.*—The faces of the pyramid uniting with those of the rhomboid, produce *parallel* edges of combination. The particular relation of the pyramid to the rhomboid, upon which this parallelism depends, is, that the horizontal projections being equal, the axis of the pyramid is to that of the rhomboid as $\frac{4}{3}$ to 1.

28. *Series of isosceles six-sided pyramids.*—Whenever the axes of two such forms are found in the requisite proportions, those forms are always capable of producing parallel edges of combination: their absolute dimensions may be what they will, provided only they are both fitted to take a share in filling up the solid. Of an isosceles six-sided pyramid. which produces parallel edges of combination with a rhomboid in the manner just explained (26.), we say that it *depends* upon that rhomboid. Hence, upon any given rhomboid, there always depends an isosceles six-sided pyra [illegible] n any principal series of rhomboids, a *series of su* [illegible] roceeding according to the w of the rhomboi [illegible] Any isosceles six-sided py-

ramids dependent on the accompanying series, (25.), are as yet unknown.

29. *Their Limits.*—On rhomboids of infinitely great or infinitely small axes, there depend, in like manner, isosceles six-sided pyramids of infinitely great or infinitely small axes. They also are regular six-sided prisms, distinguished from the preceding by their different position in combinations. These prisms constitute, moreover, the limits of the isosceles six-sided pyramids.

30. *Di-rhomboid.*—Bisect those edges of the rhomboid which do not meet the axis. Connect the points of bisection and the summits of the rhomboid by straight lines, and through these lines, extend cutting planes which may take away from the rhomboid segments, such as $f\,k\,l$, Fig. 10. Pl. VIII. The remainder will be an isosceles six-sided pyramid, represented in Fig. 9. Pl. VIII. This pyramid must not be confounded with the preceding (26.), because it has not the same proportions to the rhomboid from which it originates. If we suppose that a rhomboid, as Fig. 10. combines with itself in a position different by 60°, the pyramid will in like manner originate from this union. The figure, *in consequence of its origin*, is therefore not a simple form; but as it manifests in all respects the same relations as the simple rhomboid, it will henceforth be named a *di-rhomboid.*

31. *Examples.*—In *calcareous-spar*, $\mathfrak{z}$ (Fig. 11. Pl. VIII.) is an isosceles six-sided pyramid. If these pyramids are designated generally by $p \pm n$, and hence that one which depends upon $P = r$, by p; upon $r + 1$, by $p + 1$, and so on; then is $\mathfrak{z} = p + 2$; in other words, it depends upon the rhomboid $r + 2$, which is marked by m. In *apatite*, let s be a di-rhomboid $(30.) = r$; then is $x = p$; $r = p - 1$. In *quartz*, let s be $= r$; then is P and $z = p - 1$; $m = p + 1$. In *corundum*, *(Tableau Comparatif)*, let P be $= v$; then is r (of the figure) $= p$; $h = p + 1$. In *emerald*, let s be $= r$; then $u = p$, and $t = p - 1$. In *red silver*, let P be $= r$; then is $m = p$, and r (of the figure $= p + 1$. In *sulphate of iron*, let P be $= r$; then is $z = p$. Examples of a six-sided prism forming the limits of the pyramid are to be seen in u of the *calcareous-spar*, m of the *apatite*, r of the *quartz*, s of the *corundum*, z of the *iron-glance*, n of the *red silver*, and s of the *sulphate of iron*.

32. *Scalene six-sided pyramids.*—Let any rhomboid be placed

in an upright position. Produce the axis, to any distance, equally on both sides of the summits. From the corners of the rhomboid, draw straight lines to the extremities of the produced axis, through every contiguous pair of those lines, and the intermediate edge of the rhomboid, let planes be extended, the solid which those planes include will be a *scalene six-sided pyramid*, (Fig. 12. Pl. VIII.) In this pyramid, the edges which do not meet at the summit, occupy the same position as the corresponding edges of the rhomboid; they are hence named *rhomboidal edges;* the others *pyramidal or axis edges.* Of a scalene six-sided pyramid, whose rhomboidal edges agree in situation with the same edges of a rhomboid, we say that it is *derived* from the rhomboid, or *depends* upon it.

33. *Their proportions to the rhomboids: Their designation.*—Nature presents no scalene-pyramids, but such as are capable of uniting among themselves, or with other forms derived from the rhomboid, to produce symmetrical combinations. We obtain pyramids of this sort, if the axis of the rhomboid from which they are derived (32.) is in the first place *doubled;* in the second *tripled;* and in the third place *quintupled.* A pyramid obtained by doubling the axis is called a *primary;* by tripling it, a *secondary;* and by quintupling it, a *ternary* pyramid. Primary pyramids of this species are designated by $(p \pm n)'$; secondary pyramids by $(p \pm n)''$; ternary by $(p + n)'''$: so that the primary pyramid depending on r would be marked $(p)'$; the secondary $(p)''$; the ternary $(p)'''$: the primary pyramid depending on $r + 2$ would be marked $(p + 2)'$; the secondary $(p + 2)''$; the ternary $(p + 2)'''$.

34. *Series of scalene six-sided Pyramids.*—Upon any given rhomboid of the principal series, therefore, depend three scalene six-sided pyramids: upon that series itself, three *pyramidal series*, which proceed according to the law followed by the series of rhomboids; that is to say, their axes increase or diminish as the powers of 2, the horizontal projections being equal.

35. *Different general series of such Pyramids, and some of their Properties.*—Among themselves, these pyramids exhibit a *particular series*, the general expression for which will be $(p \pm n)'''$, $(p + n + 1)''$, $(p \pm n + 2)'$, if the general expression for the pyramids be $(p + n)^m$, and m signify the charac-

ters $'$, $''$, $'''$. It is a property of this series, that any two consecutive members, such as $(p+1)''$ and $(p+2)'$, or $(p+2)'$ and $(p+1)'''$, produce with each other parallel edges of combination, as r and x, Fig. 13. Pl. VIII., in calcareous-spar. If P (Fig. 13.) is put $= r$; then is r (of the figure) $= (p)''$ and $x = (p+1)'$; that is to say, the former is a secondary pyramid, depending on the rhomboid $P = r$, the latter a primary pyramid of the rhomboid $f = r + 1$ (32). Another property of the series is, that if any two of its terms are distant from each other by 5, or 11, or 17, or generally by $6n - 1$ terms (n being any whole number); the edges of combination belonging to those two are horizontal, when the combination itself is placed in an upright position. In the example presented by Fig. 48, Pl. xxvii. Haüy, where r and t are pyramids of this sort; r (of the figure) is $= (p)''$, and $t = (p-2)$; so that $n = 1$; and in the general series, five terms are wanting between the pair connected together.

36. *Examples.*—The following minerals afford proof that such series of pyramids actually exist. *Calcareous-spar,* $(p-2)''$, t, Fig. 48.; $(p)'$ (Monteiro in the *Journal des Mines*); $(p)''$, r, Fig. 12. Pl. VIII.; $(p)'''$, y, Fig. 22.; $(p+1)'$, x, Fig. 42.; $(p+1)''$, b Fig. 1. Pl. VIII.; $(p+2)'$ (Haüy, in the *Journal des Mines*). *Tourmaline,* $(p-1'')$, x, Fig. 123. Pl. lii.; $(p)''$ (Haüy in t. iii. *des Annales du Museum*); $(p)'''$, u, Fig. 124. *Emerald,* $(p-2)'''$ (*Romé de l'Isle,* tab. iv. 2nde suite, Fig. 103.) *Red silver,* $(p-2)''$, t, Fig. 13. Pl. lxiv. (like several in this species not accurately drawn); $(p)''$, h, Fig. 14. *Iron-glance,* $(p-2)'''$ lies between P and n, Fig. 8. Pl. VIII.; it is found in the collection of the Institute.

37. *Scalene six-sided Pyramids of the accompanying Series.*—The rhomboids of the accompanying series have, in like manner, their scalene six-sided pyramids, which depend upon them, but which do not follow the same laws as the pyramids of the principal series. They seldom appear in nature. We pass them by at present, for the sake of brevity.

38. *Transverse section of the scalene six-sided pyramid.*—A section perpendicular to the scalene six-sided pyramid's axis, and meeting the rhomboidal edges (32.), is called a *transverse section.* This transverse section is in the form of an irregular duodecagon, whose angles are unchangeable, at what point soever

the section may pass through the axis, but whose sides become equal when it passes through the middle point of that axis. A simple geometrical construction shews that the angles of the transverse section depend *upon the ratio existing between the axis of the pyramid, and that of the rhomboid from which it originates;* and hence that all such pyramids as have axes in this ratio, give the same transverse section; all primary pyramids, therefore, have one common transverse section; all secondary pyramids in like manner, and all ternary pyramids: but the transverse section of primary pyramids is different from the transverse section of primary pyramids, and that again from the transverse section of third pyramids.

39. *Limits of their Series.*—The regular six-sided prism has already been considered as a rhomboid with an axis infinitely great (22). The question now arises: What will be the condition of a primary, secondary, or ternary pyramid, originating from a rhomboid with an axis infinitely great? Draw two sections perpendicular to the axis of a pyramid, and so as to pass through the extreme points of the rhomboidal edges. The surfaces of these sections will be irregular hexagons, whose angles have a fixed relation to those of the transverse section. Examine now that segment of the pyramid comprised between the two sections just drawn. Its length, or altitude, is one-third of the axis of that rhomboid from which the pyramid is derived. Hence if the rhomboid's axis be infinite, the altitude of this segment must likewise be infinite.

Besides those two faces, which are perpendicular to the axis, this segment is bounded by twelve scalene triangles. In proportion as the ratio of the rhomboid's axis to the side of its horizontal projection augments, so much the nearer will two of the angles in each triangle approach to 180°,—the third to 0°: and when the rhomboid's axis, in comparison with the side of its horizontal projection, becomes infinite, and the rhomboid thus changes into a regular six-sided prism, then the bounds are reached, the triangles become unlimited parallelograms, and the middle segment of the pyramid becomes an unlimited *irregular twelve-sided prism.* This prism will have for its base the transverse section of the *primary* pyramid, if the middle segment in question belongs to a *primary* pyramid; the transverse *section of* the *secondary,* when that segment belongs to a *secon-*

dary pyramid; and the transverse section of a *ternary*, when to a *ternary* pyramid. The rhomboid, with its axis infinitely great, that is to say, the regular six-sided prism constituting the limit of the rhomboidal series, has thus dependent on it three scalene six-sided pyramids, also with axes infinitely great, of which one is a primary, the next a secondary, the last a ternary; and which, therefore, assume the appearance of irregular twelve-sided prisms, each dependent on its appropriate transverse section. These prisms are *the limits of the scalene six-sided pyramids.* It is observable that the regular six-sided prisms, which form the limits of the isosceles pyramids (29.), have no twelve-sided prisms of this sort: hence these prisms appear in combinations, only in *one and the same* position.

40. *Examples of the Limits.*—These prisms which, like all forms having one of their dimensions unlimited, can only appear in combinations, are exemplified by nature, in *tourmaline*, in *emerald*; some of their faces are found even in *calcareous-spar.* In *tourmaline*, the prism, which depends on the secondary pyramid, is designated by h, the general expression for these prisms is $(p \pm \infty)^m$, where m as above (35.), signifies the characters $'$, $''$, $'''$.

41. *Mathematical basis of the symmetry of Combinations.*—On glancing back over the ground we have passed, one is astonished at the multitude and variety of forms which, with an extremely small expence of mathematics, may be deduced from a given rhomboid, and submitted to very simple laws; yet the whole compass of this subject is still far from exhausted, and many remarkable phenomena relating to it have been omitted for want of room (37.) Nature combines these forms in crystalline figures. *From their dependance upon each other, and from the proportions in which they mutually stand, we may comprehend that all such combinations must possess the highest degree of regularity admitted by their simple figures, and therefore be completely symmetrical* (3.) At the present stage of the inquiry, nothing is better calculated for giving a *palpable* representation of this symmetry, than to study the crystallizations of calcareous-spar; and nothing for exciting a greater interest about that study, than to consider how simple the proportions are on which nature has founded that symmetry.

42. *Some Applications. Division of Combinations.*—The first application of the doctrines now explained respecting crystallisation, is shewn in the easy and accurate division of combinations. Fig. 4. Plate VIII. represents a combination of two rhomboids. The parallelism of their edges of combination shews, that they form two immediately adjacent members of *the same* series. Hence, if we know the dimensions of the one, we shall also know those of the other, and the magnitude of the edges of combination likewise. Fig. 13. Pl. VIII. is a combination of two rhomboids and two scalene six-sided pyramids. As the rhomboids produce parallel edges of combination with each other, they must form two consecutive terms of *the same* series: f is the more acute. And since the faces of the pyramids in like manner produce parallel edges of combination with each other, those pyramids must also form two consecutive terms of the preceding *general* series (35). Again the edges of combination between f and x, Fig. 13. Pl. VIII. are parallel to the edges of the rhomboid f; and the edges of combination between P and r, to the edges of the rhomboid P. The former pyramid, consequently, depends on the rhomboid f, the latter on the rhomboid P (32). If, therefore, we can discover that r is a secondary, or x a primary pyramid, which, after some acquaintance with these forms has been gained, may be decided by the eye itself; and if we know the dimensions of one rhomboid, P for example; from these data we are enabled to find every dimension of the whole combination. Fig. 1. Pl. VIII. represents a combination of nine simple forms. The edges between g and t are parallel to those between t and P, to the oblique diagonals of g, and also to the axis-edges of P. Let $\mathrm{P} = r$; then is $g = r - 1$. The edges between P and f are parallel to each other, to the axis-edges of f, and to the diagonals of P. Whence f is $= r + 1$. The edges between f and m stand in a similar relation; consequently m is $= r + 2$. But farther, the edges between m, y, a and b are parallel; consequently b is $= r + 3$. Hence the rhomboids included in this combination form five consecutive terms of one series—Moreover, the edges between x and f being parallel to th f f, x is a scalene six-sided pyramid depending o $+ 1$; and the edges between x and a being pa tween x and f, and therefore

to the axis-edges of f; a is likewise a scalene six-sided pyramid depending on f, or $r+1$. Conceive the faces of P and y to be enlarged till they intersect; the lines of their intersection are parallel to the axis-edges of P, &c.; and y is therefore a scalene six-sided pyramid depending on P. To find the proportions which these pyramids bear to each other, and to the rhomboids, the following considerations are sufficient. The edges formed between a and y are parallel to those between y and m. The edges between y and m are parallel to the oblique diagonals of m, and consequently to each other. Hence the edges between a and y are parallel to the obtuse axis-edges of y, and to the acute ones of a. The edges between x and y are likewise parallel to each other. (It is necessary to consider two of such a kind as have the horizontal edge formed by f and b lying between them). Therefore x, y and a are three consecutive members in a series of scalene six-sided pyramids (35). If in the preceding general expression, we put $n=1$, $n=0$, $n=+1$, and so on, we shall obtain $(p-1)'''$, $(p)''$, $(p+1')$, $(p)'''$, $(p+1)''$, $(p+2)'$, $(p+1)'''$, $(p+2)''$, $(p+3)'$. Out of these, three consecutive terms must be chosen, such that $p+1$ may appear twice, and p once; in other words, that two pyramids may result depending on $r+1'$, and one on r. The proper terms are $(p+1)'$, $(p)'''$ and $(p+1)''$. Hence x is $=(p+1)'$; $y=(p)'''$; and $a=(p+1)''$. The pyramid t remains undetermined. But if the combination included $(p)''$, whose more acute pyramidal edges have the same position as the oblique diagonals of f; this particular figure would produce horizontal edges of combination with t; t therefore must either be $(p-2)'$ or $(p-4)''$—(35), because in that case the parallel edges of combination appear for the first time. Now, could we discover the magnitude of any edge belonging to this figure,—of the horizontal edge, for instance, between b and f, which easily admits of measurement by the French goniometer; or, knowing the mineral to be calcareous-spar, could we remark that P is parallel to the form of the cleavage,—we should then know every thing necessary for computing any required dimension of this crystal.

43. *Designation of Simple Forms and Combinations.*—Our second application is an easy and clear mode of designating

simple forms and combinations, without being compelled to have recourse to plates for explanation. As all that we have hitherto been examining, is derived from the principal series of rhomboids, we must select some member of that series to be the basis of designation. It is most natural to choose that term according to which the cleavage is determined. In calcareous-spar, this is P, Fig. 2. Pl. VIII. Let us designate this species by r, then is g (Fig. 3. Pl. VIII.) $= r - 1$; f (Fig. 5. Pl. VIII.) $= r + 1$; m (Fig. 6. Pl. VIII.) $= r + 2$; r (Fig. 12. Pl. VIII.) $= (p)''$; y (Fig. 22. *H.*) $= (p)'''$; x (Fig. 42. *H.*) $= (p + 1)'$; t (Fig. 48.) $= (p - 2)''$; c (Fig. 12.) $= r + \infty$; o (Fig. 31.) $= r - \infty$; u (Fig. 10.) $= p + \infty$, &c. If it is required to designate combinations, the signs of the simple forms are placed together in the same order as the terms of the several series: The limits stand last. Fig. 7. Pl. VIII. for example, is marked by $r . r + 1$; Fig. 10. $= r . p + \infty$; Fig. 11. $= r . (p)''$; Fig. 12. $= r . r + \infty$; Fig. 7. Pl. VIII. $r + \infty . r - \infty$; Fig. 26. $= r . (p)'' . r + \infty$; Fig. 35. $= r - 1 . (p)'' . r + \infty$; Fig. 46. $= r . r + 1 . (p)'' . (p + 1)'$; Fig. 50. $= r - 1 . r + 1 . (p - 2.)'' . (p)'' . r + \infty$; Fig. 1. Pl. VIII. $= r - 1 . r . r + 1 . r + 2 . r + 3 . (p - 2)''' . (p + 1)' . (p)''' . (p + 1)''$. This mode of designation has the advantage not only of representing all the simple forms which enter into the combination, but also of expressing their mutual proportions; so that upon finding merely the dimensions of a single form, a calculation may immediately be grounded on it.

44. *Four-sided Pyramids, with square bases. Their Series and Limits.*—Besides the forms already noticed, no other can be derived *from the rhomboid.* Hence, *no other is capable of entering into combination with the rhomboid, or with any form derived from it.* If, however, we take a *four-sided pyramid, having a square base*, Fig. 14. Pl. VIII., and treat it as described, (in 12. and 17.) we shall obtain a series of four-sided pyramids with square bases, which will proceed according to the powers of $\sqrt{2}$, and whose limits will be rectangular four-sided prisms. As the horizontal projections of two consecutive pyramids are not parallel to each other, these pr [illegible] ust be regarded as in two different positions.

45. *Examp* [illegible] monstrates the existence of this series within i [illegible] case of Zircon, Tungsten, Vesu-

vian, Tinstone, Yellow Lead, Uran-Mica, Rutile, Anatase, and others.

46. *Accompanying Series.*—Upon this series depends also an *accompanying series* of four-sided pyramids, with square bases: its co-efficient is $\frac{3}{2\sqrt{2}}$. Supposing the horizontal projections to be equal, the axis of a member in the principal series is to the axis of a member in the accompanying series as $2\sqrt{2} : 3$. If P (Fig. 14. Pl. VIII.) is put $= p$, then is u (Fig. 15. Pl. VIII.) $= \pi + 3$: so that the principal series is denoted by $p + n$; the accompanying series by $\pi + n$. If c (Pl. xlvii. Fig. 70.) is put $= p$, then is n (Fig. 73.) $= \pi - 3$.

47. *Scalene eight-sided Pyramid.* — If in Fig. 183.—185. (Pl. lxxx.) the faces z, are enlarged till they alone comprehend the whole solid, a *scalene eight-sided pyramid* results. *Three* pyramids of this kind depend upon each four-sided one with a square base, in the principal series; and the axes of the former are to those of the latter as $3 : 1$, $4 : 1$, $5 : 1$. In the order here assigned to them, like the six-sided pyramids formerly mentioned (33.), they are named the *primary*, *secondary*, and *ternary*. The manner in which these eight-sided pyramids originate from the four-sided pyramids, cannot be here developed for want of room.

48. *Their Series.*—Three series of pyramids, therefore, the series of primary, of secondary, and of ternary pyramids, depend upon the principal series of four-sided pyramids with square bases. These three series present among themselves a *general* series, the expression for which will be $(p \pm n)'''$, $(p \pm n + 1)''$, $(p \pm n + 2)'$, the general expression of these pyramids (34.) being $(p \pm n)^{m}$. This general series possesses properties analogous to those of the series of scalene six-sided pyramids.

49. *Limits.*—The limits which bound this single series of eight-sided pyramids (45.) are eight-sided prisms, having the same unequal angles as the transverse section of the pyramid to which they belong. Since the horizontal projections of two consecutive four-sided square-based pyramids occupy different places, these prisms must be considered as having *two* different positions (39).

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50. *Examples.—Nature displays the* existence and the limits *of this series of eight-sided pyramids* in the following examples. *In zircon, Fig. 14 and 15. Pl.* VIII. let P be $= p$; then is $x = (p)'$, *that is to say, the simple* form that arises from augmenting *the faces f, is the primary* scalene eight-sided pyramid, originating *from the four-sided* square-based one, designated by P; *and the axis of the former* is consequently equal to three times that *of the latter. In this* same mineral are likewise found $(p)''$ and $(p)'''$: *as the Institute's* collection exemplifies. In *Vesuvian*, let o be $= p$; then is $z = (p - 1)'$; $s = (p)'$; $x = (p)''$; and $h = (p + \infty)'$, or h is the eight-sided prism with unequal angles, which forms the limit of the first scalene eight-sided pyramid. In *Tinstone*, let o be $= p$; then is $z = (p)'''$; $r = (p + \infty)'''$. In the *Transactions* of the *Geological Society*, (*Vol.* ii. *Pl.* 15. *seq.*) the fifth modification is $= (p + \infty)$. Haüy, in the *Tableau Comparatif*, p. 302, describes the same form in *Rutile*, and marks it by h, (Tab. ii. Fig. 31.) In *yellow lead-spar* also, we find $(p + \infty)'''$ marked by r.

51. *Summary of these Forms and Combinations.*—Whatever was above established (41.—43.) respecting those forms which originate in rhomboids, may also be applied to those forms which originated in four-sided square-based pyramids. The remarkable analogy which exists in all points between the one class and the other, contributes not a little to augment the interest arising from the study of both. The latter, like the former, constitute among themselves a *group*, and produce symmetrical combinations, *into which they admit nothing that cannot be derived from the fundamental form, in the mode already explained.*

52. *Four-sided Pyramids with oblique Bases. Their Limits and Series.*—A similar group will result, if, with some very slight alterations, we apply the process of derivation, explained above, (12. and 17.), to *a four-sided pyramid with an oblique base*, like Fig. 1. Pl. lxii., or such as would originate from augmenting the faces o, (Pl. xliv. Fig. 37.) From that operation [illegible] series of four-sided oblique-based pyramids arise; in [illegible]hich the transverse section at right angles to the axi[illegible] the transverse section of the original pyramid, [illegible]: o and s (Pl. xliv. Fig. 42.) present

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the preceding. Such are those that possess the *greatest*, sometimes even a *geometrical* regularity in their simple forms, and the *highest* degree of symmetry in their combinations. They can all be derived from the hexahedron (cube), by placing it upright, and considering the position of a moveable plane with regard to its faces and edges. Forms of this sort never assuming infinite directions, have no limit like the preceding. Some of them, however, have constant dimensions, while the dimensions of others are variable. The former may be viewed as limits of the latter.

55. *Their kinds and differences.*—The forms now under consideration are, 1. The hexahedron; 2. The octahedron, including the tetrahedron; 3. The dodecahedron; 4. The icositetrahedron. The first two have neither variable dimensions nor different species, the rest have both these properties. The species belonging to the dodecahedron are the *rhomboidal* dodecahedron, (whose dimensions are constant,) and the *pentagonal* dodecahedron, of which sort we already know several that differ in their dimensions. The species included under the icositetrahedron, are the *trigonal* and the *tetragonal* icositetrahedron. The first results from enlarging the faces *l*, Fig. 37., in lead-glance; it is bounded by twenty-four equal and similar *isosceles triangles:* Those belonging to the other species consist of twenty-four *quadrilateral-faces* some of which have two equal plane angles, and give rise to the first subspecies of the tetragonal-icositetrahedron. Two of its varieties are known, Fig. 191. of Analcime represents the one, the other results from enlarging the faces *r*, Fig. 104. of Pleonaste. The second subspecies of tetragonal-icositetrahedron has not two equal plane angles; three of its varieties are known, one of which arises from enlarging the faces *f*, (Fig. 148.) of pyrites, the other from enlarging the faces *s* or *o*, and *n* (*Tableau Comparatif*, Pl. iv. Fig. 60.) of the same mineral. It will be convenient to omit the more extensive of these species.

56. *Combinations. Well-defined Limits, separating the Forms hitherto considered.*—The forms that arise from the hexahedron produce among themselves various combinations; but they admit into them no form, *which either is a rhomboid, or a four-sided pyramid with a square base, or an oblique four-sided*

pyramid, or can be derived from any of these figures. And since the rhomboid, the four-sided square-based pyramid, and the four-sided oblique-based pyramid, are forms which cannot by any means be derived from each other; the *four groups* of simple forms as well as their combinations, must each be altogether distinct from the rest; and hence arises a correct and natural division of *all possible* crystallizations, which promises to be of great utility in such pursuits.

57. *Fundamental forms and systems of Crystallisations.*—We call every simple form, from which other simple forms are derived, a *fundamental form;* and the class of figures derived from that fundamental form, a *system of crystallisations.* Hence, in the mineral kingdom, there are four fundamental forms, and four systems of crystallisations.

58. *Their Denominations.*—Those systems of crystallisations might acquire their denominations from the fundamental forms on which they are grounded. Upon that principle, they would be named the *rhomboidal*, the quadrato-pyramidal, the rhomboid-pyramidal, and the hexahedral. It is more convenient, however, as well as more proper, to alter the denominations of the last three, and to call the first of them *pyramidal*, the second *prismatic*, because it contains so great a multitude of those figures, and the third *tessular*.

59. *Constant and Variable Dimensions of the Fundamental Forms. Series of Crystallisations.*—Three of our fundamental forms are *indeterminate* in their dimensions; the fourth, the hexahedron, is constant in its dimensions. The dimensions of all derived forms depend upon those of the fundamental forms; the variations of which they follow to their limits, in the rhomboidal and pyramidal systems: and in the prismatic system, to the rectangular four-sided prism, which remains always the same, how different soever the dimensions of the fundamental forms may become. In any of these three systems, if the dimensions of the fundamental form are determined, we obtain from it, by derivation, a train of forms having determinate dimensions, among which the general proportions of the system are observed. Whenever the dimensions of the fundamental form are altered, the dimensions of all such forms as result from it are altered likewise, without, however,

changing the mutual ratios which they bear to each other. The groupe that arises from a fundamental form of *determinate dimensions* is named a *series of crystallisations*, or a *special series*, because, as we shall soon see, crystallisations of one and the same species are and must be members in some such series.

60. *Examples.*—If, in the rhomboidal system, r is put = 105° 5′, the special series of *calcareous spar* results; if r is put = 133° 26′, the special series of *tourmaline* results; $r = 87°$ gives the special series of *iron-glance*, &c. In the pyramidal system, $p = 124° \ 12'$ determines the special series of *zircon*; $p = 129° \ 30'$, the special series of *vesuvian*, &c. The series of crystallisations is, hence, *that which determines the system of crystallisations for a particular case*; the system of crystallisations, on the other hand, is the *general expression for all possible series of crystallisations*, which depend upon that system. As the fundamental form in the tessular system undergoes no alteration in any of its dimensions, *only one* series of crystallisations can have place in that system.

61. *Application.*—According to what has already been advanced, when a newly discovered species of the mineral kingdom is presented to us, we are enabled to fix its system of crystallisations; and we have already obtained a general representation of all the forms, with their mutual proportions, which can possibly belong to that species; but we are not in a condition to determine any particular form, if it is not a limiting form, any other way than by its dimensions; though, when one of these forms is determined, the dimensions of all the rest may be computed from it with the utmost accuracy. The determination of any form, from a special series in the first three systems of crystallisations, must be managed *by an immediate and accurate measurement.* Hence few of them are yet sufficiently determined.

62. *Cleavage shews us the System and the Series of Crystallisations.*—The different series of crystallisations are of the highest importance for properly determining the *species* of minerals, the system [illegible] llisations for determining their characteristics. And as al [illegible] ot present themselves in a crystallised state, the [illegible] orward to compensate for the absence of crystall [illegible] *any form of cleavage, not a limiting*

form, represents some member in the series of crystallizations belonging to that species. A limiting form, however, determines the system of crystallisations, provided it be not a straight four-sided rectangular prism, in which case the choice, lying between the pyramidal, prismatic and tessular systems, must be determined by the circumstances.

63. *Determination of the ambiguous case.*—When any cleavage form is a straight rectangular four-sided prism, though from any other quarter *the smallest hint* were not given us, by which the particular system of crystallisations it belongs to could be determined, the following simple considerations will be sufficient to fix that point. A straight four-sided prism presented to us, may be 1. The hexahedron (55.), 2. The limits of the pyramidal system (44.), 3. A combination of the limiting forms of the prismatic system (52.) If the faces of the cleavage, in regard to their completeness and lustre, are each of a different nature, the form comes under the first case. If two faces of the cleavage are of the same, the third of a different nature, then the form must come under the third case. Examine the cleavage in the direction of the diagonal. If this, once more, affords a rectangular four-sided prism, it indicates the pyramidal system; if it affords an oblique angular four-sided prism, it indicates the prismatic system. When all the cleavage faces are of the same nature, the form may come under any of the whole three cases. Between the second and the third a decision must be made as above. If the additional cleavage produces a rectangular four-sided prism, seek to obtain the same figure in the direction *of another axis.* If we obtain it, the form is a hexahedron; if we cannot obtain it, the form is the limit of the pyramidal system.

64. *More extensive application by Practice.*—It is well known how far our judgments of cleavage and cleavage-forms, are rendered easy and certain by a little practice. To such a degree is this the case, that an observer can often, with great facility, determine the form in minerals, which, but for this simple artifice, would scarcely have exhibited to us any traces of regular conformation. All these and similar advantages assist us in applying the system of crystallisations to the purpose of determining minerals; hence they extend its empire to such a degree, that, as experience shews, little can escape it. But, notwithstanding

the universality of its application, nothing can be accomplished by means of it alone. To render it effectual, some other characteristics must be combined with it. Concerning these, the following circumstances deserve to be remarked.

(To be continued.)

Art. XXIX.—*Description of the Patent Water-Pressure Engine, invented by Mr* James Dickson, *Engineer.* Communicated by the Inventor.

This water-pressure engine, (which is on the principle of the Hydrostatic Paradox), like all other machines that are impelled by water, can only be useful where water descends from a higher to a lower point. The whole water employed is conveyed in a pipe, from the place where it is collected, to the cylinder of the engine, and after raising or depressing a piston in it, is carried off by another pipe to the place where it is discharged. The height of the fall is reckoned from the surface of the water in the reservoir where the pipe that conveys it to the machine is laid, to the surface of the water in which the pipe that carries it off is immersed.

Let us suppose that the water is conveyed to the cylinder C, Plate VI. Fig. 1. by a continuation of the pipe A, Fig. 2. and passes through the stop-cock 1, which is open. The stop-cock 2 being shut, the water ascends the pipe B, enters the cylinder by the valve E, and pressing against the under side of the piston, raises it through the whole range of the crank, as shewn in Fig. 1. The valves E and G being connected, are now shut, and upon the piston commencing its descent, the valves F and H, which are also connected, begin to open. The water now entering at F, presses down the piston, and the water which in the upward stroke went in at E, is now issuing out by the valve H, down the pipe L, through the cock 3, which is open, and along the pipe M, to the place where it is discharged. The column of [illegible] r below the cylinder, adds to the height of the upper [illegible] ieving the eduction orifices G and H alternately, [illegible] the atmosphere, in proportion to the perpendic[illegible] column L and M. For, if we sup-

pose, the pipe M continued, (at any slope), and the end of it immersed in water, the surface of which is 34 or more feet perpendicular below H, then, whenever the valve G or H is opened, the water issues into a vacuum, and is therefore totally freed from the resistance of the atmosphere; therefore the power of the engine must be increased, in the same manner as if a column equal to the weight of the atmosphere were added to the column A.

That no water may pass along without entering the cylinder, one set of valves shuts before the other set opens; and as water is nearly incompressible, every time it is stopped, or its course suddenly altered, when confined, as in this machine, it would give a shock to its several parts, and tend to loosen its joints. To counteract these effects in the upper column, the air-vessel O is placed on the pipe that leads to the cylinder, as near it as convenient; and when any set of valves is shut, the water in A rushes into O, and condenses the air in it more than the weight of the column A at rest would do. Hence, when the next set opens, the water is pressed out, and a current is also continuing to descend along A. The air-vessel P, which is joined to the pipe leading from the cylinder, gives to that pipe a more equal current than it would have without it; for when one set of valves is shut, the column in M would be suspended till the other set opens, which would give a concussion to the whole machine. Before the machine, therefore, is put in motion, the stop-cock 3 is shut, and 1 and 2 opened, and the water running into P expels the air through a small cock, the end of which goes down into the top of the vessel about an inch. Let us now suppose one set of valves shut, then a current will begin to flow out of P, and the air that was not allowed to get out of the top of the vessel, will be dilated; consequently, when the other set of valves opens, the air being expanded beyond what the column M at rest could keep it at, water will be drawn in by P, to be given out the next time the valves shut. Were air left in the cylinder, either in the bottom of the piston, or between the piston and cover, it would cause a halt or pause as the crank turned the centre, at top and bottom, for the air would be alternately condensed and dilated by the pressure of the upper, and the suction of the under column. Hence, a space of time would elapse before their combined effects were felt by the piston, and there would also be wasted, every *half stroke*, the quantity of water that A supplied to compress the air, and run off by M to dilate it. In order that the air, therefore, may not only be taken out at first, but that the machine may continue to discharge any that may be disengaged, by the water coming in contact with the metal or other causes, the under side of the piston is turned, to cause all the air below it to be collected at one point, and a small hole being made there, by which the air is transferred to the upper side of it, and the cover being turned in the same manner, all the air is collected at one point, in the cover; and through the underside of the flanch of the cylinder, is introduced a pipe, the end of which goes into this hollow of the cover, where the air is collected, and in the descent of the piston, the water pressing it down, also presses out the air by this tube, the other end of which is fixed into the pipe M. As the piston is always either ascending or descending, however small be the space of time between the shutting of one set and the opening of the other set of valves, the piston will have moved. In order, therefore, to allow the piston to travel during the time that all the valves are shut, and no water either coming in or going out of the cylinder, there is a small cylinder D at the back of the large one, having a communication with it at top and bottom. Into this cylinder there is fitted a piston with a screwed rod, which can be lengthened or shortened, so that this piston, with its rod, which is completely enclosed, may have a range just sufficient to contain the water that remains to be displaced from the upper side of the large piston when at the top, and the under side of it when at the bottom.

The eccentric wheel V, on the crank shaft, is connected with the levers R and S, and by alternately depressing them, opens the valves, which are shut by the weight T, as in a steam-engine. The wheel W on the crank-shaft serves to connect the engine with any other machine. When an air-pump is used, it may be connected with Z, or at different places along the pipe M.

The greatest superiority this engine has over a water-wheel is, that a fall of any height above, and to the extent of 34 feet below, can [illegible]ted in a single point, whereas the power of a water-w[illegible] to the limited extent of its diameter; and as a sma[illegible]ater from a great height, is equal to a large quan[illegible] fall, it can be used with great power in situations [illegible]heel can be of little benefit; for if

100 gallons *per* minute is equal to a certain power with 1 foot of fall, 1 gallon *per* minute will perform the same work with a fall of 100 feet. Its local conveniences also are considerable; for besides retaining the power of the fall below at any distance short of 34 feet perpendicular, that fall, with the fall to the engine, may be at any slope: There is no dampness where it works,—it requires no attendance,—is not so liable to go out of repair as a steam-engine,—it is less expensive,—and, if the power is the same, occupies still less space.

One of these engines has been erected for Sir Alexander Jardine, Bart., of Applegarth, for the purpose of driving his thrashing-machine. There is from 8 to 12 feet of fall, (according to the height of water in the reservoir) to the cylinder, and 30 feet of fall from it; and to gain this perpendicular height, it required 136 yards of pipe. Of this pipe, 80 yards is 6½ inches diameter, and 56 yards 5½. The valves are 4 inches and the cylinder 12 inches diameter, with a stroke of 2 feet, and 8 double strokes in the minute. The drum, which is 30 inches in diameter, performs 272 revolutions in a minute. The engine consumes nearly one cubic yard of water in the same time, and works with the power of two horses*.

29. Gilmour Place,
28*th May* 1820.

Art. XXX.—*On the Retrograde Variation of the Needle.* By Colonel Beaufoy, F. R. S. &c. &c. In a Letter to Dr Brewster.

Bushey Heath, Stanmore,
Dear Sir, 1*st May* 1820.

In addition to the mean monthly variation of the magnetic needle, I have the pleasure to send you a general Table, containing my observations for three successive years, from whence it appears, that the *maximum* of the western variation at this place occurred about the month of March 1819; that such is the fact, is evident, because in the first nine months of the second year's observations, the variation was greater than during the corresponding months of the first year. The needle then became constantly increasing in January, diminishing in February, and increasing again in March the same year, since which time it has decreased, as may be seen by the corresponding monthly variation of the second and third years.

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* We have seen letters, from which it appears, that Sir Alexander Jardine, a competent judge of machinery, is highly satisfied with the performance of this engine.—*Ed.*

It is on record, that in 1658 the compass pointed to the true north: the western variation has therefore been increasing for 162 years, and is now retrograde; but what is the limit of the eastern declination, remains to be determined, as I cannot find any observations on the variation of the compass prior to 1580, at which time it was 11° 15′ east. I remain, Dear Sir, yours very sincerely, MARK BEAUFOY.

TABLE, containing the Morning, Noon and Evening Monthly Mean Variation of the Magnetic Needle for Three Years.

Variation West.

1817.		° ′ ″	1818.		° ′ ″	1819.		° ′ ″
April,	Morning,	24 31 52	April,	Morning,	24 34 06	April,	Morning,	24 32 36
	Noon,	24 44 43		Noon,	24 44 50		Noon,	24 43 09
	Evening,	24 35 58		Evening,	24 36 36		Evening,	24 34 59
May,	Morning,	24 32 20	May,	Morning,	21 36 18	May,	Morning,	24 32 42
	Noon,	24 42 35		Noon,	24 45 49		Noon,	24 41 22
	Evening,	24 34 45		Evening,	24 38 35		Evening,	24 34 10
June,	Morning,	24 31 09	June,	Morning,	24 33 47	June,	Morning,	24 31 28
	Noon,	24 42 14		Noon,	24 45 11		Noon,	24 41 41
	Evening,	24 34 45		Evening,	24 37 40		Evening,	24 35 09
July,	Morning,	24 31 14	July,	Morning,	24 34 24	July,	Morning,	24 32 31
	Noon,	24 42 06		Noon,	24 44 59		Noon,	24 42 12
	Evening,	24 35 43		Evening,	24 38 14		Evening,	24 35 37
Aug.	Morning,	24 31 16	Aug.	Morning,	24 34 40	Aug.	Morning,	24 32 33
	Noon,	24 42 51		Noon,	24 45 58		Noon,	24 42 49
	Evening,	24 33 45		Evening,	24 37 50		Evening,	24 34 24
Sept.	Morning,	24 33 02	Sept.	Morning,	24 34 29	Sept.	Morning,	24 32 29
	Noon,	24 41 36		Noon,	24 45 22		Noon,	24 41 35
	Evening,	24 34 38		Evening,	24 37 28		Evening,	24 33 27
Oct.	Morning,	24 31 06	Oct.	Morning,	24 35 36	Oct.	Morning,	24 33 27
	Noon,	24 40 46		Noon,	24 43 28		Noon,	24 40 08
	Evening,	— — —		Evening,	— — —		Evening,	— — —
Nov.	Morning,	24 31 49	Nov.	Morning,	24 33 24	Nov.	Morning,	24 32 42
	Noon,	24 37 55		Noon,	24 41 41		Noon,	24 38 43
	Evening,	— — —		Evening,	— — —		Evening,	— — —
Dec.	Morning,	24 34 03	Dec.	Morning,	24 37 04	Dec.	Morning,	24 33 29
	Noon,	24 38 02		Noon,	24 41 20		Noon,	24 37 20
	Evening,	— — —		Evening,	— — —		Evening,	— — —
1818, Jan.	Morning,	24 34 02	1819.	Morning,	24 35 42	1820. Jan.	Morning,	24 34 06
	Noon,	24 [illegible]		Noon,	24 39 54		Noon,	24 37 54
	Evening,	— [illegible]		vening,	— — —		Evening,	— — —
Feb.	Morning,	24 [illegible]		ning,	24 34 17	Feb.	Morning,	24 32 19
	Noon,	24 [illegible]		[illegible]	24 39 55		Noon,	24 38 07
	Evening,	— [illegible]		ng,	— — —		Evening,	— — —
Mar.	Morning,	24 [illegible]		ng,	24 33 18	Mar.	Morning,	24 30 47
	Noon,	24 [illegible]		[illegible]	24 41 42		Noon,	24 39 33
	Evening,	24 [illegible]		g,	24 35 17		Evening,	24 33 45

TABLE, containing the Mean Variation of each Twelve Months Observations.

1st Year.		*2d Year.*		*3d Year.*	
Morning,	24° 32′ 28″	Morning,	24° 34′ 45″	Morning,	24° 32′ 36″
Noon,	24 41 14	Noon,	24 43 21	Noon,	24 40 23
Evening,	24 34 46	Evening,	24 37 29	Evening,	24 34 30

Decrease,	By the Morning observation,	2′ 09″	Mean, 2′ 42″
	By the Noon observation,	2 58	
	By the Evening observation,	2 59	

1820, April,	Morning,	24° 30′ 38″
	Noon,	24 40 29
	Evening,	24 31 58

Rain and Evaporation at Bushey Heath during the years 1819–20.

1819.

Month.	Rain.	Evaporation.
	Inches.	Inches.
January,	1.906	1.400
February,	2.828	1.430
March,	1.153	2.680
April,	2.468	3.440
May,	3.063	4.530
June,	1.950	4.250
July,	1.514	4.930
August,	2.520	4.720
September,	3.213	3.550
October,	1.610	2.280
November,	1.761	1.230
December,	2.429	0.710
Total,	26.415	35.150

1820.

Month.	Rain.	Evaporation.
	Inches.	Inches.
January,	1.02	0.36
February,	1.143	0.765
March,	0.246	4.170
April,	1.505	3.750

BAROMETER.

		Inches.	
Highest,	1st Jan. 1819,	30.021	N.N.E.
Lowest,	21st Nov. 1819,	28.628	W.N.W.

THERMOMETER.

Highest,	1st Aug. 1819,	81¼°
Lowest,	11th Dec. 1819,	18

ART. XXXI.—*Proceedings of the Royal Society of Edinburgh.* (Continued from Vol. II. p. 376.)

Mar. 6. 1820. MR ALLAN read a paper on the similarity between the rocks of Faroe and Salisbury Crags.

A paper by Dr Brewster was read, on a new species of lead ore. This paper is published in our present Number, p. 139.

Dr Yule read a notice on the properties and culture of the *Phormium tenax.*

March 21.—A paper on chances, by Charles Babbage, Esq. was laid before the Society.

Dr Brewster communicated a notice respecting a new structure which he had discovered in the Aplome garnet.

April 3.—A paper by Mr Scoresby was read, on a new machine for measuring the dip of the needle.

Professor Jameson gave an account of his particular views respecting granite veins, and other points in geognosy.

An account of the Pyramids of Gizé, by Lieut.-Col. Straton, was read, and illustrated by plans and sections.

A notice by Dr Brewster was read, respecting a singular structure in the diamond. See p. 98.

April 17.—Lieut.-Col. Straton communicated to the Society a full account of the Egyptian Temples. The account of the temple of Ipsambul is given in this Number, p. 62.

May 1.—Dr Duncan *jun.* read a short notice on the Stethoscope, an instrument invented by M. Laennec, physician of the Hospital of Neckar at Paris for investigating the diseases of the organs of the chest. It is exceedingly simple, consisting merely of a cylinder about a foot long, and an inch and a half in diameter, pierced lengthwise by a hole $\frac{3}{8}$ of an inch wide, and widened at one end in the form of a funnel the whole diameter of the cylinder. It acts partly as a prolongation of the external ear, and partly by magnifying the sounds within the chest; and, so far as Dr Duncan's experience went, he found M. Laennec's observations to be correct, and considered the instrument as well calculated to improve our knowledge of many very important and obscure diseases.

An account of the strata of the diamond mines at Mallyvully, by the late Dr James Anderson of Madras, was read. See this Number, p. 72.

Mr Cadell re [redacted] count of some idols brought from India in th year 180 impson, Esq. and presented to the Society through Cadell. They are are all carved out of talcac different grain in each figure.

At this meeting the following members were elected :

HONORARY MEMBER.

Count Itterburg.

ORDINARY MEMBERS.

Sir John Meade, M. D.
Dr William Macdonald of Ballashore.
Thomas Kinnear, Esq. Banker.

May 15.—Dr Duncan *sen.* read a biographical account of the late Dr Daniel Rutherford. Dr Rutherford was born at Edinburgh on the 3d November 1749. He took his degree of M. D. in 1772, and his thesis was entitled *De Aëre Fixo.* In this dissertation he pointed out, for the first time, a new gaseous substance, since distinguished by the name of Azote or Nitrogen. He was admitted a Fellow of the Royal College of Physicians on the 6th May 1777. In a paper on Nitre, read before the Philosophical Society in 1778, he described under the name of Vital Air, what is now called Oxygen Gas : he considered its basis as a necessary constituent of every acid ; and he even stated it as not unlikely that by this element *they were acid.* On the death of Dr John Hope, in 1786, he was elected Professor of Botany and Keeper of the Botanical Garden, a duty which he discharged till the time of his death, which took place on the 15th of November 1819, in the seventy-first year of his age.

ART. XXXII.—*Proceedings of the Wernerian Natural History Society.* (Continued from Vol. II. p. 378.)

Feb. 26. 1820. DR DEWAR read a paper on the mode of nutrition of the hair, feathers and nails of animals. This paper will appear in the third volume of the Memoirs of the Society, now in the press. At the same meeting, Professor Jameson read a letter from Dr Boué of Paris, containing an account of the resemblance of the rocks of Auvergne and the Vivarais to some of those of Scotland.

March 11.—Mr John Stewart read a paper, giving an account of a collection of North American ferns, which he had received from Dr Torry of New York. It contained specimens of several rare and interesting species ; among others, Schizæa pusilla; Lycopodium reflexum, new to North America; an Equisetum, intermediate between limosum and palustre, which seems to be of a new species, and which Mr Stewart proposed to distinguish thus: "*E. torryanum*, caulibus ramosis, ramis densis, hexagonis scabruisculis adpressis, spica terminali." It differs from the two nearest species, in the sheaths, in the angles of the stem, in height, and in general aspect.

At the same meeting, Professor Jameson read some observations on Dr Boué's comparison of the trap-rocks of Auvergne to those of Scotland, and showed, in particular, that the rocks of Arthur's Seat Hill, in the neighbourhood of Edinburgh, must have had the same origin as those of Salisbury Crags, &c.

March 25.—The Secretary read a communication from Mr Stevenson, civil engineer, relative to the state of the bottom of the German Ocean or North Sea, and the changes it is undergoing; illustrated by sections, founded on numerous soundings. The substance of this paper will be found in our present Number, p. 42. At the same meeting, the Secretary communicated the descriptions, by Mr Swainson of Liverpool, of two new species of Picus from the interior of Brazil.

ART. XXXIII. *Proceedings of the Cambridge Philosophical Society.*

First Meeting, Feb. 21. 1820.—1. DR THACKERAY presented to the Society a curious fossil body, picked up on the coast of Scarborough. He afterwards read a short notice, explanatory of its locality and probable origin.

2. The President (Professor Farish) read the first part of his paper on *Isometrical Perspective.* He first stated the difficulties he had formerly experienced in obtaining such representations of machinery as might be sufficient to enable a common workman to set up the complex models used in his lectures. To remedy this, he adopted a perspective, in which all the parts of any solid are laid down on the same scale. Thus a cube may be [illegible] by a hexagon, in which lines are drawn from [illegible]es to the centre. In this perspective the equal [illegible]id are obviously represented by

equal lines drawn *in plano.* On the same principle, he demonstrated a series of other propositions, which became the foundation of precepts for the application of the perspective to more complex cases. He afterwards gave some details on the advantages to be derived from an extended application of similar methods.

3. Dr E. D. Clarke communicated his discovery of *Cadmium* in some of the English ores of zinc, and gave a short account of his mode of operating.

4. The results of a series of experiments made by Captain Fairfax, in order to determine the soundings at sea, by observing the times of descent of different waves, were read to the Society.

March 6.—1. A letter from the Rev. J. Hailstone was read by one of the Secretaries. It described an appearance presented by the weathered surfaces of several specimens of calcareous sandstone found in the cliffs near Scarborough. The exterior surface of the specimens presents a number of club-shaped or conical masses, sometimes branching one from the other, which stand out in high relief. The appearance was supposed to take its rise from some marine production of the actinia or mollusca tribe, the organization of which is known to be very confined, and whose substance bears a small proportion to the superficial extent which the animal is enabled to occupy when expanded by water.

2. The President concluded his communication on the subject of isometrical-perspective.

3. Extracts were read from a paper " On the Reduction of certain Classes of Functional Equations to Equations of finite differences." By J. F. W. Herschel, Esq.

4. A paper by Mr J. Okes, On some Fossil remains of the Beaver found near Chatteris in Cambridgeshire. The first part of his paper contained some historical details, proving the beaver to have been at one time an inhabitant of Great Britain. It was then shewn, by quotations from Dugdale's History of the Fens, that the place where the bones were found, had formerly been a considerable branch of communication between the Ouse and the Nen, though it has now been choaked up for more than two centuries. After giving some anatomical details, intended to prove that the fossil bones in question belong to an animal of the same species as the beaver of Canada, the au-

thor concluded by observing, that the situation in which these bones were found, agrees with what Cuvier had previously determined, viz. "That the bones of species which are the same with those which still exist alive, are never found except in the very latest alluvial deposits, or those which are either formed on the sides of *rivers*, or on the bottoms of ancient lakes or *marshes*."

March 20.—1. A paper was read on the Geology of Cornwall, and some other parts of the West of England, by Professor Sedgwick. The first part of the paper was devoted to some general considerations on the structure of the county. The phenomena presented by the granitic tracts were afterwards described. All the points on the coast where the granite and slate are seen in contact, were enumerated, and a minute account was given of the singular appearances exhibited at the junction of the two formations between Porth-Leven and Mirazion. From a general consideration of these phenomena, the author endeavoured to establish the following conclusions. (1.) That on a great scale the killas rocks conform to the granite; but that at the line of contact, the slaty laminæ do not appear to exhibit any disposition towards conformity with the irregularities of the surface on which they repose. (2.) That in all situations where there is a good denudation, (and, therefore, by analogy, throughout the whole contact of the granite and the slate,) many prolongations of the central granite pass into the superincumbent schist, and by their varied ramifications, which have every possible inclination and direction, produce the phenomena of granite veins. (3.) That these veins, with very limited exceptions, produce no alteration in the dip or line of direction of the schistose masses with which they are associated. (4.) That in the few instances in which metalliferous bodies intersect the beds which contain granite veins, both the killas and the veins contained in it, have undergone the same disturbance. (5.) That it is probable that the granite veins are cotemporaneous with the rock which they traverse, &c. &c. The reading of the remaining portion of the paper was postponed.

2. A Trar [redacted] (by Mr Thompson of St John's Coll.) from Gemmelaro' t of the eruption of Ætna in 1819, was read.

ped by crystals with one axis of double refraction on exposure to polarised light."

3. Observations on the Notation employed in the Calculus of Functions. By Charles Babbage, Esq. was read. His object was to give some account of the important consequences which had followed on the adoption of improvements in notation. He then explained, by elaborate examples, the advantages to be derived from the notation of functions in its present improved state.

Last Meeting in the Easter Term.—May 15.—1. A paper by Mr Emmet on the Mathematical Principles of Chemical Philosophy was read.

2. Dr E. D. Clarke read a paper *On the Purple Precipitate of Cassius.* He concludes from his experiments, 1. That the two metals which are chemically combined in the purple powder of cassius, do not exist in a constant relative proportion. 2. That in whatever proportion the gold may exist with regard to the tin in the purple precipitate, there is no evidence to warrant the opinion of its being in the metallic state.

3. Professor Sedgwick concluded his paper on the Geology of Cornwall, &c. by describing the schistose rocks and the subordinate beds.

4. A paper by Mr Christie was read "On the Laws according to which Masses of Iron influence Magnetic Needles." Instead of the hypothesis, that a mass of iron, disturbing a needle by becoming a magnet, having its north and south poles in the upper and lower part respectively, Mr Christie supposes the needle to be guided in its horizontal direction by magnetic particles passing through its centre in the direction of its natural dip; and the iron to act principally, if not wholly, on these particles, causing, by their deviation towards it, a corresponding deviation of the horizontal needle. In confirmation of this, he found by experiment, that when the disturbing mass is placed at the same distance from the magnetic axis and the centre of the needle, the deviation of the horizontal needle, when properly estimated from the magnetic axis, is always the same, whether the mass be pl [illegible] he north, or the south, or any other point of the compa [illegible] to the needle. In a series of elaborate experimen [illegible] mean coincidence of their results with those to w [illegible] bove described would lead.

ART. XXXIV.—*Proceedings of the Astronomical Society of London.*

March 10. 1820. A PAPER was read, entitled, " On the doubly refracting power of rock-crystal as a means of micrometrical measurement, by the Rev. W. Pearson, LL. D. F. R. S.

The late Abbe Rochon pointed out a very ingenious mode of constructing a micrometer by means of two prisms of rock crystal, cut and united in a peculiar manner. By placing between the object-glass and eye-piece of a telescope, a double image is produced, and these two images may be brought into contact by means of a contrivance for bringing the prisms nearer to or more remote from the eye-piece. The most prominent disadvantage of this plan is the difficulty and almost impossibility of procuring plates of rock-crystal of sufficient size and of uniform density. To remove this impediment, Dr Pearson constructs a prismatic solid, (a solid consisting of two prisms, united in such a manner as to have two parallel faces, and produce two images), and places it before the eye end of the telescope. This separated the two images of the object examined by a constant angle, depending on that of the prism; and in order to bring the images into contact, an eye-piece of variable power is applied to the telescope. By separating the lenses of which it consists, a gradual increase of power is produced, and the divisions on the outside of the eye-tube point out the power *. The constant angle of the prisms, divided by the magnifying power of the instrument, is the angular measure of the object examined. In the course of this paper, the author notices that the opticians of Paris, when directed to cut a prism of rock-crystal which shall separate the images of an object any given number of *minutes*, make the angle of the prism itself equal to same number of *degrees*.

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* This variable eye-piece was invented by Dr Brewster in 1805, and a drawing and description of it was then sent to Mr Carey. The application of it to double image micrometers is described in his Treatise on New Philosophical Instruments, p. 66. 67. This eye-piece was many years afterwards brought out at Paris by M. Cauchoix, under the title of *Polyalde*, and the invention of it has been ascribed to this ingenious artist in the *Edinburgh Review*, vol. xxxii. p. 374. The same eye-piece forms the subject of a paper recently read before the Royal Society of London by Dr Kitchener, who is said to have improved it.—ED.

April 10.—A paper was read "On the construction and use of a new micrometrical eye-piece of a telescope;" by the Rev. W. Pearson, LL. D. F. R. S. Member of the Astronomical Society of London.

The object of this communication is to explain the practical construction of the new prismatic micrometer, and the astronomical eye-piece which Dr Pearson had invented, and to give to the Society the results of some observations he had made with that instrument. In order to determine the power of the telescope in any given position of the lenses composing the eye-piece, it is necessary to be acquainted with the focal distances of the several glasses of which it consists. The mode by which Dr Pearson ascertained the focal distance of any small lens was as follows: He placed it as the eye-glass to an object-glass, whose focal distance was accurately known; thus forming an astronomical telescope of the simplest kind, having measured, by means of a dynameter, the magnifying power of this instrument, the focal distance of the eye-lens is equal to the focal distance of the object-glass divided by the magnifying power. At the conclusion of this paper are given several tables of measurements of several planets and double stars effected by an instrument of the kind above described.

May 12.—A letter was read from the Rev. G. Peacock, A. M. F. R. S. Fellow of Trinity College, Cambridge, to C. Babbage, Esq. F. R. S. L. & E. giving an account of the means taken for establishing an observatory at Cambridge. It is proposed to provide two sets of instruments, one of which will be employed solely by the observer and his assistants. It is understood that these are to have every perfection which the present state of the art can give them; and in mentioning the name of Mr Troughton as their maker, all other recommendation will be unnecessary. The other set of instruments are to be of less costly construction, and are intended for the instruction of those members of the University who may be desirous of acquiring a knowledge of practical astronomy. The University have given L. 5000 [illegible] mencement of a subscription, which it is hoped wi[illegible] 15,000,—the sum which is estimated as the pr[illegible]f the establishment.

A paper was read, on Double Stars, by James South, Esq.

Since the publication of a paper containing many valuable observations on this point of Astronomy, by Sir William Herschel, Kt., to which the author pays a just tribute of admiration, little has been added by subsequent observers. The improvement in fixed instruments since the paper alluded to was written has been so great, that the author has proposed to employ them in examining these interesting objects, and a considerable number of the observations contained in the table accompanying this communication, were made with an achromatic telescope, capable, in favourable circumstances, of magnifying 500 or 600 times, which is attached to an equatorial, used as a transit instrument. Mr South observes that an erroneous opinion is prevalent, that it is impossible to separate double stars except in the absence of the moon and of twilight; but that this is in very many instances unfounded, and that he has separated small double stars even during the presence of a meridian sun.

ART. XXXV.—SCIENTIFIC INTELLIGENCE.

I. NATURAL PHILOSOPHY.

ASTRONOMY.

1. *Mr Dick's Observations on Venus.*—Mr Thomas Dick of Perth observed the planet Venus on the 16th October 1819, when she was only 6 *days and* 19 *hours* past the time of her superior conjunction with the Sun. Her distance from the Sun's eastern limb was then only 1° 28′ 42″. From this observation Mr Dick concludes, 1. That Venus may be distinctly seen at the moment of her superior conjunction with a moderate magnifying power, when her geocentric latitude exceeds 1° 44′ 47″; and, 2. That during the space of 583 days, or about 19 months, the time Venus takes in moving from one conjunction with the Sun to a like conjunction again, when her latitude at the time of her superior conjunction exceeds 1° 44′ 47″, she *may be seen, by means of an equatorial telescope, every clear day without in-*

terruption, except at the moment of her inferior conjunction, and four days before and after it. Mr Dick considers day observations as of great utility, in ascertaining whether or not Venus has an atmosphere, as Schroeter supposes; and he suggests the propriety of employing them, with the view of discovering if any planets exist in the immense interval of 37 millions of miles between Mercury and the Sun. In making day observations, Mr Dick has always found, that the opaque screen which is used to intercept the direct rays of the Sun, produces an effect corresponding to its distance from the object end of the telescope.

OPTICS.

2. *Distant Visibility of Mountains.*—The following observations on the distance at which mountains have been seen possess considerable interest:

	Authorities.	Distance in Miles.
Himalaya Mountains,	Sir W. Jones,	244
Mount Ararat from Derbhend,	Bruce,	240
Mowna Roa, Sandwich Isles (53 leagues),		180
Chimborazo (47 leagues)		160
Peak of Teneriffe from South Cape of Lanzerota[*],		135
Peak of Teneriffe from ship's deck,		115
Peak of the Azores,	Don M. Cagigal[†],	126
Temaheud,	Morier,	100
Mount Athos,	Dr Clarke,	100
Adam's Peak,		95
Ghaut at the back of Tellichery,		94
Golden Mount from ship's deck,		93
Pulo Pera from the Top of Penang,		75
The Ghaut at Cape Comorin,		73
Pulo Penang from ship's deck,		53

The last six observations, and that of the Peak of Teneriffe, were made by a writer in the *Calcutta Monthly Journal.* An example of a brig being seen in Scotland, at the distance of 95 or 100 miles, by Captain Colby, will be found in this Journal, vol. i. p. 411.

3. *Hauyne.*—From some good crystals of this rare mineral, which Dr [illegible] lately received from J. G. Cogswell, Esq. he h[illegible] hat it has no double refraction, and

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[*] Humbol[illegible] ive, vol. i. p. 98. The Peak of Teneriffe has been often seen [illegible] agues.

[†] *Id.* p. 99

therefore that its primitive form is either the cube, the regular octohedron, or the rhomboidal dodecahedron. Some of the crystals have obviously the form of the rhomboidal dodecahedron. The specimens which Dr Brewster had formerly examined, had received a polarising structure from fusion and rapid cooling.

ACOUSTICS.

4. *Account of the Sirene, an Acoustic Instrument.*—This instrument, which has received the name of Sirene, from giving out its sounds under water, has been proposed by Baron Cogniard de la Tour. It consists of a circular copper box, four inches in diameter. The upper surface is pierced with 100 oblique apertures, each a quarter of a line in width, and two lines long, arranged in a circle round the axis. In the centre of this surface is an axle, on which a circular plate turns by a current of air, or by means of a simple mechanism. This plate has also 100 apertures corresponding to those in the surface of the box below it, having the same obliquity, but in the opposite direction. The obliquity of these apertures is not necessary to the production of the sounds, but serves to give motion to the circular plate, by the impulse it receives from the currents of air which issue from the apertures in the box. The wind of a pair of bellows being conveyed to the box by means of a tube, the circular plate is set in motion, and the apertures in the surface of the box are alternately open and shut to the passage of the air, by which means a regular series of blows is given to the external air, and a sound analogous to that of the human voice is produced, becoming more or less acute according to the greater or less velocity of the plate. When water, in place of air, is made to pass through the apertures, sounds are equally produced even when it is entirely plunged in the fluid, and the same number of concussions produces the same sound as in the air.—*Ann. de Chim.* xii. 167. This instrument is nearly the same as the one invented by the late Dr Robison, and described in the old *Suppl.* to the *Encyc. Brit.* Art. TEMPERAMENT, or in his works now printing, vol. iv. p. 404. "The intelligent reader," says Dr Robison, "will see here an opening made to great additions to practical music, and the means of producing musical sounds, of which we have at present scarcely any conception; and this

manner of producing them is attended with the peculiar advantage, that an instrument so constructed can never go out of tune in the smallest degree."

5. *Voice changed by breathing Hydrogen.*—Mr Cooper has found, that if a person speaks immediately after breathing hydrogen gas, for a few moments his voice suffers a change, which soon goes off.—*Journ. of Science*, No. xvii. p. 182.

6. *Humboldt on the Increase of Sound during the Night.*—It has been remarked, even by the ancients, that the intensity of sound is greatly increased during the night. Humboldt was particularly struck with this fact when he heard the noise of the great cataracts of the Orinoco in the plain which surrounds the Mission of the Apures. This noise is three times greater in the night than in the day. Some writers have ascribed this to the cessation of the humming of insects, the singing of birds, and the action of the wind upon the leaves of trees; but this cannot be the cause of it at the Orinoco, where the humming of insects is much greater in the night than in the day, and where the breeze is never felt till after sunset. Humboldt therefore ascribes it to the presence of the sun, which acts on the propagation and intensity of sound, by opposing them with currents of air of different density, and partial undulations of the atmosphere, caused by the unequal heating of different parts of the ground. In these cases, the waves of sound are divided into two waves, where the density of the medium suddenly changes, and a sort of *acoustic mirage* is produced, arising from the want of homogeneity of the air, in the same manner as the *luminous mirage* is produced from an analogous cause.—*Ann. de Chim.* tom. xiii. p. 162.

7. *New Musical Instrument.*—M. Schortman of Buttstead has invented a new musical keyed instrument, the tones of which are produced by short rods of burned wood, of various lengths and breadths, thrown into a state of vibration by a current of air. Its pianissimo resembles the Eolian harp, and it is described as imitating th[illegible]rmonica, clarionet, horn, hautboy, and violin.

8. *Met*[illegible] *on the Violin and the Violincello at the same t*[illegible] Watson, a blind musician from Dundee, has in[illegible] by which he can play upon these two

instruments at once, with the greatest facility and correctness. He plays on the violin in the usual manner, and on the violincello by means of his feet. His right foot goes into a sort of shoe at the end of the bow, and in consequence of his right thigh being supported by a spring attached to the chair on which he sits, he has the full command of his foot, without suffering any fatigue. By means of his left foot he acts upon a set of levers, by which he shortens the strings with great facility. Mr Watson has frequently played thirteen and fourteen hours in one day, without any extraordinary fatigue.

MECHANICS.

9. *Physical Strength of Men.*—M. Coulomb, in his fine Memoir on the Physical Strength of Men, after remarking that he had always found the grenadiers to perform a third more work than the other companies, observes, that the mean quantity of action varies with the nature of the food, and particularly with the climate. " I have executed," he says, " great works at Martinique by the troops, when the thermometer rarely stood below 68° Fahrenheit; and I have executed in France the same kind of work by troops; and I am assured, that under the 14th degree of latitude, where the men are almost always inundated with perspiration, *they are not capable of half the quantity of daily work which they can furnish in our climate.*" The following experiments by Peron, with Regnier's dynamometer, shew that the individual strength depends also on the climate.

English, - -	71.4
French, - -	69.2
Timor, - -	58.7
Van Diemen's Land, -	51.8
New Holland, -	50.6

HYDRODYNAMICS.

10. *On the Application of a Jet of Water to drive a Water-wheel.*—M. Morosi of Milan has found that the force of a jet of water is greatly increased by raising a rim about half an inch high round the circumference of the disc upon which it is thrown. The following results were obtained by directing a stream of water one inch square, against a plain disc, and one with a raised edge.

Height of water in the reservoir.	Force exerted on the plain disc.	Force exerted on the disc with a raised edge.
6 feet.	5 lb.	11 lb.
8	7	15
10	9	20

M. Morosi applied rims 2 inches high with great success to the vertical float-boards of a horizontal wheel, leaving an aperture below, to allow the water to escape after it had expended its force on the float-boards. This construction may be considered as an extension of the principle of *concave float-boards*, which have been long used in horizontal wheels, and which the Chevalier Borda found to give in practice a greater effect than plain ones in the ratio of 3 to 2. A fuller account of Morosi's experiments will be found in the *Bibliotheque Universelle*, vol. xii. p. 217.

11. *Compressibility of Water.*—Mr Perkins, the ingenious inventor of the siderographic process of engraving described in p. 141., appears to have ascertained that water is compressible in a much greater degree than it appeared to be from the experiments of Canton and Zimmerman. "Having filled a cylinder, three feet long and four inches diameter, with water, into which a rod or piston was passed through a stuffing box, and having a sliding ring upon the rod, the whole was lowered 500 fathoms into the sea, when it appeared, by the situation of the sliding ring, that the column of water which pressed upon the piston, had sunk it so as to have compressed the water *one hundredth* part of its bulk. The same apparatus was placed in a cannon filled with water, and secured very tight, when a pressure equal to 500 fathoms, was forced in by means of the hydraulic press, and the same results as in the experiment in the ocean took place." London *Journal of Arts*, No. II. p. 140.

MAGNETISM.

12. *Daily Variation of the Needle at Spitzbergen.*—Mr Fisher, who ac[illegible]nied the expedition under Captain Buchan to the Spitzl [illegible] ıade a series of observations on the daily variatio [illegible] upon a small island on the N. W. coast of Spitzl [illegible] e 79° 40′ 20″.6, and longitude 11°

7′ East. The mean of the observations, taken before noon, from the 13th to the 21st of August 1818, was - 26° 40′ 0″
and of those taken afternoon, - - 27 1 20

Difference, - 0 21 20

—*Journal of Sciences*, N° 17. p. 99.

13. *Daily Variation of the Needle at Edinburgh.*—Andrew Waddel, Esq. F. R. S. E. has just erected an apparatus at Hermitage Hill, near Leith, for measuring the diurnal variation of the needle. The results of his observations will be regularly communicated in this Journal.

METEOROLOGY.

14. *Meteoric Stones.*—The celebrated M. le Marquis de la Place, whose name was the principal support of the lunar origin of meteoric stones, has now abandoned this hypothesis, and embraced that which gives them a more distant origin. In a recent paper on the lunar tables, read before the French Board of Longitude, on the 29th March 1820, he asks, "are the motions of the planets, and the satellites sensibly altered by the attraction of comets, and by the impulse of small bodies, similar to meteoric stones, which we see falling upon the earth, and which appear to come from the depths of celestial space."

15. *Extreme Heat at Bagdad.*—It appears by letters from Bagdad, dated the 25th August 1819, that the heat of the summer there has exceeded any thing that was ever experienced in that country. "The thermometers, placed in the coolest part of the house, rose to 120°, and at midnight were sometimes at 108° in the open air. There had been in the commencement of August a storm, accompanied by a heavy rain, an event quite unprecedented, and the effect of it, on the burning soil already overheated by the fierce simoom, was similar to that of the hottest steam bath. Multitudes of people, both in the country and in the streets of the city, dropped down dead from the intense heat. A small caravan lost 22 persons in this manner in the last three days of its journey towards Bagdad. The river rose in one night 7½ feet above its ordinary level, and became of a turbid-red colour, and the waters were so offensive, that it was

impossible to drink of them. The extreme heat had subsided at the date of the letter, but the thermometer even then was at 105°.

16. *Dreadful Storm in Kutch.*—The district of Kutch, which suffered so severely from an earthquake in June last, (see p. 120. of this Number,) was exposed on the 9th October to a dreadful storm, which continued two days and two nights. The trees were torn up by the roots; the fields laid waste, and towns and villages destroyed by the inundation of the rivers and brooks. Few of the inhabitants lost their lives, but great numbers of cattle were destroyed. In the plains the water rose generally to the height of four feet, and ploughs were carried away to the distance of several miles by the violence of the wind.

17. *Rain and Earthquake in Java.*—On the 8th March it rained so heavily for 24 hours in the territory of Diagorogo, that a number of the hills were burst with the water. The hill of Paroda was rent in five different places to the length of three roods in each place; three houses were buried in the earth, and a Javanese killed. Masses of earth rolled about from the hills of Somlio, Tromper, Maughe, Pasges and Bodollo, (all of which were rent,) into the rivers Kayen and Klito, by which 30 houses were destroyed.

On the 29th of March a severe earthquake was experienced in Djokjokarta, from N. W. to S. E. accompanied by a noise like the rolling of a number of carriages. The shock was repeated three times. In the Hussar Barracks, the sabres hanging on the wall struck one another so violently, that the officer on duty thought the men were fighting. *Asiatic Journal*, vol. ix. p. 409.

II. CHEMISTRY.

18. *Gliadine and Zimome.*—M. Taddey has found that the gluten of wheat may be decomposed into two principles, *gliadine* (from γλια *gluten)*, and *zimome* (from ζυμη ferment.) The former is sol [illegible] nd the latter insoluble, in alcohol. See *Annals of Phi* [illegible] . 390.

19. *Curi* [illegible] *ing Guiacum with Wheat Flour.*—M. Taddey [illegible] hat a fine blue colour was develop-

ed by mixing powdered guiacum and wheat flour, employed M. Rudolphi to prosecute the inquiry. M. Rudolphi found, 1. That when the guiacum and pure starch are kneaded together, no colour is developed. 2. That the guiacum scarcely becomes blue when the flour contains little gluten, or when the flour has undergone any alteration in its qualities; and, 3. That when gluten or zimome is kneaded with powdered guiacum, the mixture assumes a very pure blue colour. *Giornale de Physic.* 2d Bimest. 1819.

20. *Indigo.*—Dr Thomson has found that indigo, in the state of a greenish-yellow soluble pigment, is composed of

5	atoms oxygen,	- -	5.00
7	carbon,	- -	5.25
1	azote,	-	1.75
			12.00

Ann. of Phil. No. xc. p. 467.

21. *Camphor.*—Dr Thomson has found that camphor melts when heated to 288°, and boils at the temperature of 400. He ascertained it to be composed of

$8\frac{1}{2}$	atoms carbon,	- -	6.375
10	hydrogen,	- -	1.250
1	oxygen,	- -	1.000
			8.625

Ann. of Phil. No. lxxxix. p. 392.

22. *New Alkali called Brucine.*—This new alkali was discovered in the false Angustura bark *(Brucea anti-dysenterica)* by MM. Pelletier and Caventou, who discovered strychnine. (See Vol. I. of this Journal, p. 210.) When brucine is dissolved in boiling alcohol, and crystallised by spontaneous evaporation, it yields colourless and transparent crystals, in the form of oblique quadrangular prisms.

23. *Spontaneous Combustion of Cloth.*—About 25 pieces of cloth, each of which contained nearly 30 ells, were deposited upon wooden planks in a cellar at Lyons, on the 8th July 1815, in order to conceal them from the armies which then overran France. In the manufacture of the cloth, 25 lb. of oil were used for a quintal of wool, and the cloth was quite greasy, each

piece weighing from 80 lb. to 90 lb. The cellar had an opening to the north, which was carefully shut up with dung, and the door was concealed by bundles of vine props, which freely admitted the air. On the morning of the 4th August an intolerable smell was felt, and the person who entered the cellar was surrounded with a thick smoke, which he could not support. A short time afterwards he re-entered with precaution, holding a stable lanthorn in his hand, and he was astonished to perceive a shapeless glutinous mass, apparently in a state of putrefaction. He then removed the dung from the openings, and as soon as a circulation of air was established, the cloth instantly took fire. In another corner of the cellar lay a heap of stuffs which had been ungreased and prepared for the fuller, but they had suffered no change. The above particulars were carefully established by M. Cochard.—*Comte rendu des Travaux de la Soc. Roy. D'Agricult. et Hist. Nat. de Lyons, pour* 1817.

24. *Morphia.*—Dr Thomson has found that the constituents of *morphia* are as follows:

		Or nearly in volumes.
Hydrogen, -	0.0555	18
Carbon, -	0.4528	24
Oxygen, - - -	0.4917	10
	1.0000	

Hence the weight of an integrant particle of morphia is 40.25. *Annals of Phil.* No. xc. p. 470.

25. *Rosin.*—Dr Thomson has found that common rosin consists of

		In atoms.
Carbon, -	7.500	10
Hydrogen, -	1.375	11
Oxygen, -	3.000	3
	11.875	

Ann. of Phil. No. xc. p. 469.

[redacted] I. GENERAL SCIENCE.

26. *Growt* *Nivalis, the colouring matter of Red Snow.*— s found that the red globules of

this fungus vegetated and produced new fungi when they were placed in fresh snow. He ascertained that they vegetated in water alone, but in this case they produced *green* in place of red globules. The original fungi were killed by exposure to excessive cold; but their seeds retained vitality, and when immersed in snow, regenerated new fungi, generally of a red colour.

27. *Description of Rare Plants in the Botanic Garden at Berlin.*—The first number of a description of the rare plants growing in the Botanic Garden at Berlin has just appeared, under the auspices of the minister who presides over the scientific department. The plates are coloured, and the arrangement of the whole is like that of Andrews' Repository.

28. *Sudden change of Habit in an exotic Plant.*—Three years ago, Sir G. S. Mackenzie received from Mr Macnab, of the Botanic Garden at Edinburgh, a plant of the *Tritoma media*, a native of the Cape of Good Hope. This plant was remarkable for coming into flower at the beginning of our winter, which is the summer of its native climate, and continuing in flower sometimes till the middle of May. Last year, Sir George Mackenzie informs us, he had occasion to take up his plant to divide the offsets. Three of them came into flower, one in September, and the other two towards the end of October; but the flowers were totally destroyed by the severe frost of last winter, and two of the plants killed. A fourth offset did not show any flower in autumn, but continued vigorous, notwithstanding the frost; and, contrary to the usual habit of the plant, it shot up the flower-stalk in the month of May. We should be glad to be informed by any persons who may possess the tritoma media, whether they have remarked a similar change of habit.

29. *Geological Map of Germany.* We understand that Baron Leopold Von Buch has been long engaged in collecting materials for a geological map of Germany, to the publication of which mineralogists will look forward with much impatience.

30. *Mr Knight on the difference between Spring and Winter felled Timber.*—Mr T. A. Knight has ascertained, by direct experiment, that there is a striking difference between the properties of spring and winter felled timber; the former absorbing much more moisture than the other. He is of opinion, that oak

timber would be much improved if the tree, after being barked in the spring, was permitted to stand till the following winter.

31. *Population of Glasgow.*—It appears by a census which terminated on the 26th February 1820, that the population of Glasgow is 148,798.

32. *Bristol Institution.*—A new Literary and Philosophical Institution has been founded at Bristol. The foundation-stone of a magnificent building for this purpose was laid on the 29th February 1820.

33. *Society of Civil Engineers.*—On the 2d January 1818, a number of persons practically connected with the profession of a civil engineer, met and agreed upon the plan of an institution, and have since that time been employed in forming laws and regulations for its government. Having accomplished this part of the object, it was resolved at a meeting held on the 3d February 1820, to invite Thomas Telford, Esq. civil engineer, to become President of the Society. Mr Telford having accepted this office, the institution may be considered as established, and an opportunity is now afforded to qualified persons to become Ordinary, Corresponding, or Honorary Members. The leading objects of the institution are, 1st, To form a depository of useful facts, of descriptions of various works, of new inventions, of discoveries, &c. on subjects connected with the profession of a civil engineer. 2d, To collect a library of books *, maps, drawings, &c. which are useful in the profession. The number of members is limited, and is divided into three classes: 1st, Ordinary Members, are those who, by profession, are practical engineers, and whose places of residence admit of their general attendance at the meetings. 2d, Corresponding members (by profession practical engineers) are those whose places of residence do not allow of their frequent attendance at the meetings. 3d, Honorary members are persons who have written on topics connected with the profession of an engineer, and from whom no pecuniary contribution is expected. From the ability and zeal of many of the gentlemen who take the lead in this Society, we entertain very sanguine hopes that it will be an institut[illegible] honourable and useful to our country.

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* In this the [illegible] great progress, and already possesses a most valuable collection [illegible]

34. *Personal Conflict between Lieutenant Collet and a Tiger.*—Lieutenant Collet of the Bombay Army having heard that a very large tiger had destroyed seven inhabitants of an adjacent village, resolved, with another officer, to attempt the destruction of the monster. Having ordered seven elephants, they went in quest of the animal, which they found sleeping beneath a bush. Roused by the noise of the elephants, he made a furious charge upon them, and Lieutenant Collet's elephant received him on her shoulder, the other six having turned about and run off, notwithstanding the exertions of the riders. The elephant shook off the tiger; and Lieutenant Collet having fired two balls at him, he fell, but again recovering himself, he made a spring at Lieutenant Collet. Having missed his object, he seized the elephant by her hind leg, and having received a kick from her, and another ball, he let go his hold, and fell a second time. Supposing that he was now disabled, Lieutenant Collet very rashly dismounted, with the resolution of killing him with his pistols; but the tiger, who had only been crouching to take another spring, flew upon Lieutenant Collet, and caught him in his mouth. The strength and intrepidity of the Lieutenant, however, did not forsake him: he immediately fired his pistol into the tiger's body; and finding that this had no effect, he disengaged his arm with all his force, and directing the other pistol to his heart, he at last destroyed him, after receiving twenty-five severe wounds.—*Asiatic Journal*, No. 53. p. 460.

35. *Remarkable Cascade in Bavaria.*—The small river Ache, which rises in the cavern of the Glacier of Mount Tauren, runs through the valley of Achenthal, and after reaching the Gulf of Tauren, it throws itself over an elevation of 2000 feet. There are five great falls, the last of which forms a most magnificent arch of waters, which is resolved into a spray before it reaches the ground. The noise of the waters is so terrible, that it is heard at the distance of more than a league, and the current of air produced by the descent of the water is so violent, that it drives back those who attempt to advance towards the Gulf. It is necessary, therefore, to approach it by walking backwards.

36. *Golden Image of the Idol Vishnu.*—This valuable image was found at Nassick in May 1818, with jewels and other property belonging to the Peishwa. It is composed of the purest

gold from Mount Ophir, and weighs 370 tolas. Since 1707, when it was made, it has been preserved with the highest veneration as one of the principal household deities in the family of Leewajee and his descendants. A numerous and expensive establishment of bramins, and other attendants, were maintained for it. It accompanied the late Peishwa in all his pilgrimages, in a state palanquin, escorted by some of his choicest troops. During the late Mahratta war, the deity was sent in this manner to Nassick, where it was discovered by the British authorities, and sent to Poonah. As it is intended to be sold, it is hoped that the East India Company will purchase it for their museum. It is now deposited in the Company's baggage warehouse.—*Asiatic Journal*, vol. ix. p. 352.

Art. XXXVI.—*List of Patents granted in Scotland since 9th February* 1820.

3. To William Rodger of Suffolk Street, Charing Cross, county of Middlesex, Lieutenant in the Navy:—Invention, "A substitute for an anchor, which he calls a Block Anchor." Sealed at Edinburgh 22d March 1820.

4. To William Brockedon of Poland Street, county of Middlesex, gentleman:—Invention of "Certain improvements in wire-drawing." Sealed at Edinburgh 22d March 1820.

5. To Apsley Pellat the younger, of St Paul's Church Yard, London, gentleman:—Invention, For "encrusting into glass vessels and utensils, white, or other coloured, painted, or otherwise ornamented figures, arms, crests, cyphers and other ornaments, made of composition, metal, or other suitable materials." Sealed at Edinburgh 22d March 1820.

6. To Josiah Parkes of the city of Warwick, cotton-manufacturer:—Invention, "A new and improved method of lessening the consumption of fuel in steam-engines and furnaces in general, and for consuming smoke." Sealed at Edinburgh 30th May 1

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THE

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ART. I.—*Account of the Correspondence between Mr* PARK *and Mr* MAXWELL, *respecting the Identity of the Congo and the Niger*. By the Rev. WILLIAM BROWN, D. D. Minister at Eskdalemuir. Communicated by the Author. (Continued from p. 114. No. V.)

THE information contained in a former article, with a tender of his Loango and Mayumba vocabulary, formed the substance of Mr Maxwell's first letter to Mr Park. That Mr Park might enjoy the advantage of all the experience which Mr Maxwell derived from sixteen voyages to Africa, twelve of which were up the Congo, as master of a trading vessel, and conducted, as we have seen, with unusual intelligence and ability, Mr Maxwell wrote him a second letter three months afterwards, (1st January 1805,) in which he communicated some additional information, of which the following is a literal abstract.

Mr Maxwell's ascent of the Congo, as formerly stated, would have been conducted under the pretence of trade, which would have enabled him to secure the fidelity of those natives whom he must necessarily have hired at Cabenda or Embomma. But, in the event of its being prosecuted entirely as a voyage of *discovery*, the case would be somewhat altered; for he did not know how far such a number of the natives could then be depended upon. As Banza Congo, however, is reckoned the Montpelier of Africa, we may reasonably conclude that the marsh effluvia, arising from the low grounds and stagnant water about the mouth of the river, are attracted and condensed by the mountains east of Embomma, rendering the country to the eastward of these mountains healthy like Banza Congo, (which is said to be at no great distance,) as his boats indeed found, when trading to Noki Congo, 60 miles above Embomma. A European, therefore, would probably sustain the fatigue of such an expedition tolerably well. A hundred whites, in ten boats, to provide as much as possible against casualties, and fitted out in the way he proposed in his former letter, having only a prince or chief from Cabenda, with three or four of his domestics as linguists, who could easily be procured there, might surmount every difficulty. Mr Maxwell had no hesitation in declaring it as his firm belief, that, in either of these ways, such an adventure might be conducted to a prosperous issue in five months, even should the Congo prove to be a continuation of the Niger, allowing 100 days to ascend the stream, and 50 to return. He had, however, not much doubt of the identity of the two rivers, as none but a northerly direction would afford scope for a longer course than eight or nine hundred miles; a distance very inadequate, indeed, to the collection of such a vast quantity of water as is discharged by the Congo. As the commonly received opinion of the Niger losing itself in lakes, rests solely on the authority of the ancients, we may reasonably suppose, that when sickness, the jealousy of the natives, the river swelling to an inland sea, like Lake Superior, or any other cause, determined them to relinquish the pursuit, they would, as their only apology, say that it ended there: and we may readily imagine, that in many places, it does expand into immense lakes. But we are not left to conjecture on this point, for that the Congo does so, says Mr Maxwell, is past all doubt, from the innumerable islands of bulrush and other aquatic plants that are continually floating down; and these islands indisputably come from above the falls, for they could not be formed on the margin of a rapid running river, some of them being 60 yards in diameter, having their roots firmly entangled and wove together, as may well be supposed from their sustaining the concussion at the cataracts in such large portions; rendering it necessary, while vessels lie at anchor in the stream, to have a man constantly at the helm to steer clear of them. Should Gove[illegible]t, therefore, undertake this expedition, Mr Maxwell thi[illegible]e boats and men could easily be sent out in some [illegible]hips, that are occasionally ordered on these stati[illegible] run up the river with perfect freedom and safety, by the chart, to Oyster Haven, where the boats could be got out, and dispatched upon the survey. And when they had completed their researches, and returned down the river, the boats could be sold to the shipping lying there, and the men take their passage to the West Indies in the first vessels that sailed, unless a frigate happened to be upon that station at the time. Mr Maxwell entertains little apprehension of the success of such an adventure, even with white people, though there can be no doubt that a certain proportion of blacks would answer the purpose much better, if they could be trusted; and he thinks, that a choice set of boat-boys, if that was thought advisable, might be hired at Cape Coast and Anna Maboe, through the influence of the governor of that settlement. It would also be of the first consequence, he thinks, to ascend the river while it has the least water and current, and the strongest sea-breezes; he would, therefore, instead of the time formerly pointed out as best suiting himself in the way of trade, advise those going on a voyage of discovery, to set off with their boats about the latter end of August, or the beginning of September, during which last month, and the greater part of October, they would experience less difficulty than at any other season; for he had no doubt of the sea-breezes, during these months, extending 300 or 400 miles up the country. His boats found them as strong at Noki Congo as they were lower down the river; and at that distance, he concludes, the country begins to be more upon a level, as the river must then, considering its rapid descent for 150 miles, from Boola Beeka to the ocean, and the mountainous nature of the country through which it issues, be nearly upon the same elevation with the source of the Senegal, which perhaps has not a run of more than 700 miles, 300 of which are in the tide's way. The Mayumba traders that Mr Maxwell met with corroborated this idea; for they told him, that their country was one continued forest, and that the river (Enzaddi) there, appeared much larger than at Embomma; and from the number of days they had been upon the road, he calculated that they had travelled upwards of 400 miles. He also thought that the season he recommended for their departure would be peculiarly favourable for passing the cataracts, as it would not require the boats to be carried so far, in order to avoid the com-motions below, and the suction above the falls, as it would do during the flood; and besides, it would be the very best time to encounter the rains, which constitute the only formidable obstacle to such an adventure, as they would have commenced in North Africa three months before the boats set out from Oyster Haven, and by thus leaving the rains behind them, they could experience no wet weather until dropping down the river four months afterwards. The best time therefore, according to Mr Maxwell, for Mr Park and his party to leave England, allowing the vessel a three months' passage out, would be the end of May.

Such was the correspondence between Mr Maxwell and Mr Park; the whole of which evidently turns upon two points; 1st, Whether the Congo can reasonably be admitted as the mouth of the Niger? and, 2dly, If admitted, whether it would be better to ascend the stream in quest of Wangara, or descend the Niger in quest of the Congo? The first of these points, viz. that the Congo is the outlet of the Niger, appears probable from the immense size of the river, when compared with the short distance between the sea and the back-bone of the country; from its having the colour of brick even at the end of the dry season, when all the other great rivers of Africa, beyond the reach of the tide, are of a blue or dark colour. From the vast number of floating islands, of which it is never free, (Mr Maxwell informed me that he saw generally three or four large ones every day, all the time he was in the river), and especially from its annual increase into full flood six weeks before the rains commence in South Africa;—"these circumstances evidently shew, that its volume of water is entirely disproportioned to its apparent geographical domain; and that it draws its resources from a greater distance to the northward than is generally supposed. In fact, it appears to have robbed all the rivers on the western shore of Africa of their birth-right; for though many of them are navigable as far as the tide goes, yet when compared with the Congo, they dwindle into brooks, which proves that it can be no great distanc [illegible] he sea to their source, and that there must, during the r [illegible] four months, be a prodigious accumulation of [illegible] ward of the mountains from which they take the [illegible] without an adequate drain, like the Congo, would inundate a great extent of the interior of Africa. We have indeed heard much of the influence of evaporation; but when applied to the present case, the question still recurs, how has the Congo so far outstripped all its fellows? It must draw its immense resources from some quarter; and there does not appear a more likely hypothesis than that which supposes it to stretch to Wangara, past the Mountains of the Moon, and thus become the outlet of that immense drain which is known to exist in the interior of Africa."

There is but one objection to this reasoning that appears in any degree formidable, and which was stated to Mr Park, although not contained in the correspondence; namely, the difference of time between the floods of the Niger and the Congo, which is no less than three months. The answer given was in substance as follows. From every account which Mr Park obtained of the Niger, it appears to be a sluggish running stream, between Silla and Wangara. And, in confirmation of this, we may remark, that in the memoir at the end of Mr Park's Travels, it is particularly stated by Major Rennel, that the distance between Tombuctoo and Houssa is 200 miles, which takes the merchants eight days, in their ordinary way of sailing, to go and return. With us it may appear an unnecessary waste of time, being no more than a mile per hour straight forward; but those conversant with the inland navigation of rivers, know well how troublesome those calms are, which are occasioned by clumps of trees and elevations of the shore. They frequently, in the sea-phrase, "take the wind from the sails," and leave him to the rate of the current alone. It is not to be wondered at, therefore, if these 200 miles, with the necessary windings of the river, which we may estimate at 32 miles more, should take them eight days in descending, when the boats are heavily loaded, for this is at the rate of 29 miles per day. But how, it may be said, can they return in the same time from Houssa to Tombuctoo? I answer, it is particularly mentioned, in this last case, that they can only do it when they have a good breeze; for if the windings of the river be 232 miles, and the progress of the stream which they have to overcome be about a mile per hour, or 192 miles in all, this makes the real distance between the two places to be 424 miles, or 53 miles per day, which, even with use of sails, is perhaps fully as much as they can accomplish. From these observations, then, it appears, that in descending to Houssa, in whatever way they sail, they do little more than float down the stream during their eight days voyage; but that, in returning to Tombuctoo, they need the assistance of a good breeze to reach it in the same length of time. Allowing, therefore, a mile per hour as the average rate of the current, and supposing the distance between Wangara and the uppermost falls of the Congo to be 2000 miles, which appears from the Map to be not too great an allowance, after including the necessary windings, it will take nearly three months for the flood of the Niger to reach Embomma. On the whole, then, it appears not unreasonable to suppose, that the Congo may be the outlet of the Niger; and I have sufficient evidence to enable me to assert, that such was the opinion of Mr Park himself.

But still the other point remains to be investigated, Whether it would be better to ascend the Congo in quest of Wangara, or descend the Niger in search of the Congo? From the perusal of the foregoing correspondence, one would be led to think the first of these plans undoubtedly the best; but the African Association, for reasons certainly that seemed to them satisfactory, chose the second. Accordingly, Mr Park left Britain January 28. 1805, accompanied by his brother-in-law Mr Alexander Anderson as surgeon, and Mr George Scott as draughtsman, originally from Selkirkshire; H. Goree, a lieutenant, and about fifty men of the African Corps, stationed there, volunteered their services. But by a letter from Mr Park, dated Sansanding, in the November following, all the above, except himself and four others, had fallen a sacrifice to those baneful distempers the fever and flux. At that time, he expected to be in Britain in May 1806; but many years alas! have elapsed without the arrival of this adventurous and interesting traveller. By a letter, indeed, from Sierra Leone, lately exhibited in the public papers, (February 12. 1812), his fate seems to be fixed, for it is there stated, “ that some pr [redacted] which he had entrusted to a chief to deliver to the I uctoo, not having been delivered, and some rem subject having been made, the ruffian determi im; and that Mr Park and his companions, seeing their fate to be inevitable, embraced each other, and plunged into the Niger, where they perished." It is added, that "the canoe itself overset, and all his property, memorandums and papers were lost." It will be some gratification, perhaps, to be informed, that whilst Government insured him of a handsome provision in the event of his return, it was also stipulated, that in consequence of his death, his widow should receive a suitable annuity, and that, in order to fulfil this engagement, L. 3236, 10s. were voted by Parliament, 2d April 1808.

Here I might allow the matter to rest; but as the route which Mr Park took has been so disastrous, and as, at some future period, the suggestion of Mr Keir may perhaps be acted upon, I shall add some observations which Mr Maxwell was pleased to communicate along with the correspondence; and which, from his intimate acquaintance with the African climate and character, certainly deserve attention. "I cannot think," says he, "of closing the subject, without offering a few remarks on the line of conduct pursued by the African Association, on Mr Park's second attempt to explore the course of the Niger by the same route in which he suffered such variety of hardship and distress a few years before. One would have supposed, that if the course of the Niger, with its towns, population, trade, &c. had been the ultimate object of their researches, nothing new could have been looked for on that head, as far as Silla; and as for traffic, they could not reasonably expect that an adventurous Briton or two, pursuing the track of their coffles, across 1000 miles of wilderness once a year, would do away the expence, toils, and dangers of the journey, or cause the trade to flow in greater abundance to the sea coast, than it had done for centuries before, unless the natives found their advantage in it; that is, found a better market there than they do at present, or with the Moors to the northward. His interesting narrative leaving the reader's mind so completely satisfied of his veracity, we cannot but wonder at his rashness in again exposing himself to such imminent perils,—increased, too, in proportion to the number of his followers; and lament that it should have been the occasion of depriving the nation of one so admirably calculated for prosecuting that hazardous enterprise And especially so, when we have undoubted authority for believing, that he went out under the firm persuasion of the Congo being the outlet of the Niger, and which his queries to me clearly insinuate. But thinking no doubt, that, by descending the river, he would save two-thirds of the delay and fatigue of the navigation; and erroneously judging, perhaps, that his splendid equipment (as applied to Africa) would make an impression on the simple natives, he suffered himself to be deluded into that fatal security which, in all probability, has proved his ruin. When his going out in the old route, with a suite of fifty persons, under the imposing colour of embassy, was first announced to the public, I immediately, without consulting an oracle, predicted the tragic fate of the whole party; and am quite astonished that Mr Park, who has delineated the Negro and Moorish character with so much truth and feeling, should have been so deluded as not to foresee the accumulated perils of such an adventure. In no part of Africa (Dahomy excepted) have I ever seen or heard of any thing like pomp or ceremony observed in the intercourse between native princes. Besides, when a number of men are seized with an endemic, (a disorder which invariably attacks Europeans in fifteen or twenty days after their arrival on the coast of Africa), their numbers, for they must necessarily have been crowded in a small space, instead of affording mutual aid, or inspiring confidence, only increase the virulence of the disease; and the intrepid hardy individual, who might singly, perhaps, have withstood the attack, seeing his comrades fall around him, sinks in despondency and shares their fate. Mr Park is a strong instance of this, and shews what privations, dangers, and difficulties may be surmounted by enthusiasm and perseverance; and yet, with a large share of these essentials, and a robust constitution to boot, even he would often have fallen a victim to hunger, cruelty, and sickness, but for a protecting Providence, and three or four good Samaritans who administered to his wants. So that, in every point of view, he has been wrong in thus commencing his journey; for, if [illegible] tives marvelled so much at his singly encountering so n[illegible]s and dangers, "far from his mother and wife, [illegible] nd his corn;" asking of him, if there were no rivers in his own country, "that he came so far to behold and drink of the Joliba;" what must have been their astonishment when he returned amongst them with fifty armed followers? Would it not create jealousy, and induce them, from safety and the fear of future evils, instead of furthering, to retard his progress?—In the foregoing letters, I have endeavoured to explain the advantages of a water communication with the interior of Africa, for the purposes of commerce; and that without it, there is an utter impracticability of carrying on trade in any other way than has been done for ages past, owing to the jealousy of the natives, and the sickliness of the climate. But were I disposed to penetrate the wilds of Africa for the nobler purpose, as the Association gives out, of visiting human nature in its most abject condition, introducing the light of the Gospel, and the blessings of civilised life, I would proceed upon the plan pointed out in my letter of 1st May 1803 to Mr Keir, by means of native African youth, brought home and educated for the purpose, as the Portuguese are in the habit of doing in the kingdom of Angola, where they have numerous establishments. And if the spirit of adventure could not be laid asleep whilst they were training, I would go upon that plan with which the Association originally set out; and as the Niger has already been explored the length of Silla, and the situation of the Lake Dibbie, with the positions of Tombuctoo and Houssa tolerably well ascertained, I would commence my journey on foot from Whidah or Benin, if the monarch of either of those countries could be prevailed upon to patronise the undertaking. These capitals cannot be more than 500 miles from Waugara, which would at once determine whether it there ended in lakes, as has been asserted. The protection of the Eyos, too, the most powerful nation in Africa, and who undoubtedly border upon the river, might, in all probability, be obtained through the interest of Ardrah, a trading state upon the coast: in this route the adventurer would be freed from the machinations of the Moors, which alone I consider an insurmountable obstacle to tracing it in the direction hitherto attempted. The success of the benevolent views of the Association, in advancing the sacred cause of Christianity in that country, depending much on the course of the Niger, as being the likeliest means of affording a ready and safe communication with the different states; its extent and geographical situation becomes a matter of much interest, whether it issues by the Congo, or has some other outlet. But it may be proper to state, that since my letters to Mr Park, I have been informed by a friend, that when he was on the coast he purchased a few slaves at Lagos, *who could write Arabic, and who told him that they had come the whole of the way from their own country to Lagos by water*, —a fact which certainly merits consideration. As a pedestrian, then, and Mr Park's unaffected narrative warrants it, I would strictly adhere to simplicity, if not poverty of appearance, having neither horse nor servant. Of course, I could possess little to excite their avarice, or give occasion to plunder or violence; whilst my defenceless, destitute situation, would, as he experienced, be sure to call forth their sympathy and compassion. Indeed, I have little doubt, that the self-same savage, who might be tempted to rob or murder me for a few glass beads or buttons, would, if no such allurements existed, open his hut to receive me, and share with me his vegetable meal. For instances in support of this, we need only advert to the genuine hospitality and kindness which Mr Park experienced in his utmost need from the tender-hearted woman, who, with her maidens, prepared his supper and sung him to rest in a stormy night; and the good old Dooty, indignantly tossing his arm when he heard of the inhuman outrage committed on Bambarra's stranger,—who recovered his horse, without which he could not have reached Kamalia, where honest Karfa, like a ministering angel, lighted up his nearly extinguished spark of life, and filled his fancy with a train of bright ideas. Such precious instances of glowing philanthropy cannot be surpassed by Europeans, and may serve as a sample of what the *western* Ethiopians were as a people 3000 years ago, when the gods of the Greeks held their annual festival of twelve days with that innocent and virtuous race. Alas! how widely different is their lot in the scale of humanity now, to what it was when they drev such general admiration and praise.—Having alread beyond all moderate bounds, I shall not offer on, but you will observe, that I calculate upon t sure success of these researches, as only to be accomplished in two ways, both widely different from the ruinous plan hitherto pursued; and these are, either by employing natives in the various missions, properly educated and instructed; or by means of boating on the Congo, or other navigable rivers that may be found to communicate with the Niger, or penetrate far into the country."

I shall now conclude this article with Mr Maxwell's vocabulary of the Loango and Mayumba languages, as spoken in 1790. It is referred to in the foregoing letters; and while it may be exceedingly useful to those who may afterwards prosecute the line of discovery by the River Congo, it may assist the philologer in determining whether there is any affinity between these and the ancient languages of the Cushites, Phenicians, and Egyptians to the eastward.

A Numerical Table in the Loango and Mayumba Tongues.

1	Emosse, Emoica or Chemoica
2	Ezolle or ewalli
3	Etattu
4	Eemna
5	Etaana
6	Sambanoo
7	Samboalli
8	Enaano
9	Evoa
10	Ecoomi
11	Ecoomi chemoica
12	Ecoomi ewalli
13	Ecoomi etattu
14	Ecoomi eemna
15	Ecoomi itaano
16	Ecoomi sambanoo
17	Ecoomi samboalli
18	Ecoomi enaano
19	Ecoomi evoa
20	Macoomi moalli
21	Macoomi moalli chemoica
22	Macoomi moalli ewalli
23	Macoomi moalli etattu
30	Macoomi matattu
31	Macoomi matattu emoica
32	Macoomi metattu ewalli
33	Macoomi matatu etattu
40	Macoomi maana
41	Macoomi maana emoica
42	Macoomi maana ewalli
43	Macoomi maana etattu
50	Macoomi mataano
51	Macoomi mataano emoica
52	Macoomi mataano ewalli
53	Macoomi mataano etattu
54	Macoomi mataano eemna
60	Macoomi masambanoo
61	*Macoomi masambanoo* emoica
62	Macoomi masambanoo ewalli
63	Macoomi masambanoo etattu
70	Loo samboalli
71	Loo samboalli emoica
72	Loo samboalli ewalli
73	Loo samboalli etattu
80	Loo enaano
81	Loo enaano emoica
82	Loo enaano ewalli
83	Loo enaano etattu
90	Loo evoa
91	Loo evoa emoica
92	Loo evoa ewalli
93	Loo evoa etattu
100	Encamma
101	Encamma emoica
102	Encamma ewalli
150	Encamma macoomi mataano
151	Encamma macoomi mataano emoica
160	Encamma masambanoo
161	Encamma masambanoo emoica
170	Encamma loo samboalli
171	Encamma loo samboalli emoica
180	Encamma loō naano
181	Encamma loō naano emoica
190	Encamma loō voa
191	Encamma loō voa emoica
200	Ewalli chicolaazi
201	Ewalli chicolaazi emoica
300	Etattu chicolaazi
500	Etaano chicolaazi
700	Samboalli chicolaazi
900	Evoa chicolaazi
950	Evoa chicolaazi macoomi mataano
1000	Eicolaazi

ENGLISH	LOANGO	MAYUMBA
The head,	Entoo	Entoo
The hind head,	Cusso ze entoo	Cusse ze entoo
Fore head,	Endoonzee ze entoo	Boolo ze entoo
The eyes,	Maisoo	daisoo
The eye-brows,	Ensanja ze maisoo	Keeka ze daisoo
The nose,	Eeloo	Bombæ
Bridge of the nose,	———	Banga embombæ
The mouth,	Moonwa	Nooa
The tongue,	Loo leemi	Loo deemi
Spittle,	Matta	Mantai
The ears,	Mattoo	Cootoo
Hair of the head,	Blainghe	Sooki or Lainghe
The neck,	Lainga	Lacca
The belly,	Voomee	Voomo
Loins,	Mneunga	Meyoanga
The elbow,	Cuddi ze coco	Chinaisso ze coco
The arm-pit,	Seimpaccayea	Seimpaccanea
The hair of the arm,	Meeka	Meeka
The thumb,	———	Laimba emgoodi
The fingers,	Laimbo	Laimba emsuso
The nails,	Zallo	Enzalla
The knee,	Ecoongaloo	Ecoonganoo
The leg,	Coolo	Tanga coolo
Calf of the leg,	Vooma ze coolo	Soonyea coolo
The ancle,	Cuddi ze coolo	Chincusso ze coolo
The hough,	Fucco ze coolo	Foacca ze mallo
The heel,	Cuddi ze mallo	Soughi tambi
Sole of the foot,	Tambi ze mallo	Che tambi
The foot,	———	Tambi
The instep,	Enceela ze mallo	Neema tambi
The toes,	Laimbo ze mallo	Laimbo
Small of the back,	Coonda coonda emboosu	*Enzeela enzambi!*
The shoulder,	Veembo	Saingwa haimba
Tears,	Mansangæ	Mansangaze
The flesh,	Soonyea	Soonyea
A dead body,	Voombi	Voombi
A crowd of people,	Baanto	Endonga
A man,	Eyaccala	Bayaccala
A woman,	Bakainta	Bachainta
A boy or girl,	Alaize	Monna laika
A child,	Moana	Moanna
A dwarf,	Dodo	———
A negro,	Feota	Lombæ
A white man,	Emondeili	Emoondeili
A mulatto,	Emwailo	Emwailo
An albino, or white negro!	Doondo	Doondo
The elephant,	Enzawæ	Enzaoo
A sheep,	Mai-mae	Endónnæ
The goat,	Encombæ	Tabba
The cat,	Waiye	Bomba
The lion,	Cusse	Cosse
The leopard,	Engoh	Magainde
The mouse,	[illegible]	———
The rat,	[illegible]	Engonie
The wild man [illegible] in height.	[illegible]	———
The oran outan,	[illegible]	Enzeccoo
The monkey,	[illegible]	Encaywa

ENGLISH	LOANGO	MAYUMBA
The parrot,	Encoosu	Coosu
A fowl,	Soosu	Cooncou
A duck,	Vadanja	Vademjou
A pigeon,	Baimbæ	Baimbæ
A year,	Seevou	Seehou
Night,	Boeela	Queela
Midnight,	Maseeka	Maseeka
A musket,	Emtah	Tah
A tobacco pipe,	Teemba	Sooh
Brandy,	Malavu mampoota	Malamma mamgwalla
Palm wine,	Malavu masamba	Malamma mamfeekou
A small bell,	Mayoya	Mawoway
Eggs,	Macho	Mahi
A battle,	Veeta	Zeengou
The ocean,	Emboo	Emboo
A song,	Coonga	———
A ship,	Macoombi	———
A boat,	Enzaaze	———
A slave,	Baveeca	———
A prince,	Foomu	———
A priest,	Boonzie	———
A priestess,	Soonzie boonzie	———
A doctor,	Ganga emkisse	———
A fool,	Baba	Momcoocama
A villain,	Endotchi	Endoki
A husband,	Nooni	Pongo
A wife,	Cazzi	———
Medicine,	Blonga	———
Milk,	Chaala	Mavoomina
A stone,	Taddi	———
A musket-ball,	Tooza	———
Paper,	Emcanda	———
Ink,	Endeembo	———
Beautiful,	Neava	———
Bitter,	Cheloola	Endoode
Cold,	Chozee	———
To bind,	Beendica	———
To unbind,	Beendula	———
A sore or ulcer,	Poota	Poota
The itch,	Enquallala	Feecima
The yaws,	Encoodu	Boba
The small pox,	Chingenya	Calla
A cold,	Voove	———
A cough,	Ecollolo	Cohola
To bathe,	Yubbela	Cobbela
A madman,	Lawæ	Lawæ
Madness,	Lawakisse	Lawæa
To be drunk,	Ecollo	Ecollo
A language,	Baimba	Baimba
To speak,	Soasa or Tooba	———
Truth,	Cherrica	Cherrica
To tell a lie,	Lavoonu	Lahoonu or Mayamma
To roast,	Couca	Couca
To peel,	Toonda	Toonda
To boil,	Lamba	Lamba
A rope,	Emseenga	Seenga
To pull,	Volla	Holla
Mighty,	Mweinge	Keinge
Short,	Coofe	Coofe

English	Loango	Mayumba
To kill,	Vonda	Honda
Pepper,	Doongwa	Noongu
A bird,	Noonie	———
The wing,	Mavavǽ	Mahahee
The bill,	Zodea	Jubbo
The down,	Mavooze	Mavoonie
A feather,	Loosalla	Loosalla
Indian rubber,	Emvotche	Emvoke
Tell the truth,	Tooba cherrica	———
A ripe plantain,	Tibba cha foolaca	Tibba cha foolaca
A ripe banana,	Totta cha foolaca	Totto cha foolaca
A bunch of palm nuts,	Chazze chimbah	———
Many bunches of do.	Beazze chimbah	———
A canoe,	Boattoe	———
Many canoes,	Meattoe	———
Very dear,	Saiza bene	———
A noted thief,	Kapaikale	———
A little fellow,	Deekide	———
To curse,	Locolo engoozie	———
A butterfly,	Loombaimba	———
Be quiet,	Lingama	———
Noise,	Youka	———
Silence,	Moodeyoma	———
To drink,	Nooah	———
Having drank,	Noweene	———
Him or her,	Naande	———
Thou,	Accu	———
Me,	Meenou	———
That,	Onna	———
This,	Awo	———
Altogether	Eonso	———
A poisonous bark	Cassah	Emboondo
The person appointed to administer it at their ordeal trials	Ganga em cassah	———

A NURSE'S SONG.

Linga ma Chinchuddi, Linga ma.	Be quiet, Chinchuddi, be quiet;
Moana wa coolaca, wailize, Chinchuddi,	The child is sleeping, go away Chinchuddi;
Linga ma, &c. &c.	Be quiet, &c. &c.

A peculiarly plaintive Air, sung at the close of a Buffalo Hunt, supposing some of the Party to have been killed by that Animal.

Empaccasa Neunyanoe
bam Tillinia Leonga,
Mommi Maame.

ART. II.—*Notices respecting the Himalaya Mountains, and the Sources of the Jumna and the Ganges, &c.* By JAMES BAILLIE FRASER, Esq. *

IN the first number of our Journal, we were enabled, through the kindness of Mr Fraser Tytler, the friend and relation of Mr Baillie Fraser, to present our readers with a general notice of his interesting journey through part of the Himala Mountains, and to the sources of the Jumna and the Ganges. The extracts from his manuscript journal, which Mr Tytler read before the Royal Society of Edinburgh, and the magnificent drawings which he exhibited, of the wildest and most interesting scenery of that stupendous range of mountains, excited a high degree of interest, and we are persuaded, that this interest will be sustained by the perusal of the work itself. It would be inconsistent with the nature, as well as with the limits of a Philosophical Journal, to follow Mr Fraser along the line of his route, or to attempt to give even an abstract of his observations on the natural history of the country, or on the manners and institutions of its inhabitants. All that we can pretend to accomplish at present, is to select some of those descriptions which are remarkable from their novelty, or which belong more immediately to the subject of Physical Geography.

Account of the Ghaut or Pass of Comharsein.

At the village of Comharsein, in a petty state of the same name, which occupies two valleys stretching from the crest of the Whartoo Range to the Banks of the Sutlej, there is a singular descent to the river, which attracted Mr Fraser's particular notice.

"We found," says he, "the descent prodigiously steep and long, very nearly three miles; the first part somewhat circuitous, but the last mile was a continued flight of irregular steps, rudely constructed from the materials afforded by the mountain. These stones are of a very hard quality, composed of quartz, and have been laid with considerable art, one step being formed by the small ends of long pieces, which are deeply buried in the hill side, and the next by similar long pieces, laid crosswise upon the first, so as to prevent the possibility of their moving. The fatigue of such a descent is very great, and was increased to the imagination, by the view of the endless diminishing flight of steps that stretched below us, for there is little variation or turning in the whole length of this extensive staircase.

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* Extracted from the *Journal of a Tour through part of the snowy range of the Himala Mountains, and to the Sources of the Rivers Jumma and Ganges.* By JAMES BAILLIE FRASER, Esq. Lond. 1820. 1 Vol. 4to pp. 548.

"About 150 feet above the river, there is a certain quantity of table land, which was distributed irregularly along the banks of every winding of the stream. The soil here appeared to be good, and it is all well cultivated, chiefly with rice. The breadth of the stripe in no place exceeded 200 yards. Perhaps the productiveness of this table land may have formed one reason for the construction of the Ghaut we descended; which, in point of length, steepness, and singularity of construction, is surpassed by nothing I have heard of, and is as well worth seeing as any thing I have met with in India. * * *

"The perpendicular height of Comharsein above the river cannot be so little as 3000 feet. There must be *several thousand steps* in the rude flight of stairs above described, and these, added to two miles of steep and irregular descent at first, cannot well give a less positive elevation. Just at the top of the long flight of stairs, we found an orchard of apricot trees, the fruit of which was nearly ripe. * * * * On the banks of the river we found several huts of gold finders, who gain a livelihood by washing the sands of the Sutlej for the gold they contain. This precious metal is found in considerable quantities on its banks, and, it is said, comes from gold mines of some consequence in Bootan."

Account of the J-hoola, a singular Bridge over the Sutlej at Rampore.

"A communication is kept up across the Sutlej by means of that singular and dangerous kind of bridge which in the hills is termed a *J-hoo* [redacted] At some convenient spot, where the river is rather n he rocks on either side overhang the stream, a stou is fixed horizontally upon or behind two stro re driven into the banks on each side of the water; and round these beams ropes are strained, extending from the one to the other across the river, and they are hauled tight, or kept in their place, by a sort of windlass. The rope used in forming this bridge is generally from two to three inches in circumference, and at least nine or ten times crossed, to make it secure. This collection of ropes is traversed by a block of wood hollowed into a semicircular groove, large enough to slide easily along it, and around this block ropes are suspended, forming a loop, in which passengers seat themselves, clasping its upper parts with their hands to keep themselves steady; a line fixed to the wooden block at each end, extending to each bank, serves to haul it and the passenger attached to it from one side of the river to the other.

"The *J-hoola* at Rampore was somewhat formidable, for the river tumbles beneath in a very awful way, and the ropes, though they decline in the centre to the water, are elevated from 30 to 40 feet above it. The span is from 90 to 100 yards. Although it was evident that the actual danger was small, it was not without certain uncomfortable feelings that I first launched out in the machine to cross the Sutlej."—p. 260.

Singular method of treating Infants when asleep.

"At a miserable village called *Bahun*, we witnessed a very extraordinary practice, to which the inhabitants of the hills submit their young children. Several straw sheds are constructed on a bank, above which a cold clear stream is led to water their fields, and a small portion of this, probably of three fingers breadth, is brought into the shed by a hollow stick, or piece of bark, and falls from this spout into a small drain, which carries it off about two feet below. The women bring their children to these huts in the heat of the day, and having lulled them to sleep, and wrapped their bodies and feet warm in a blanket, they place them in a small bench or tray horizontally, in such a way that the water shall fall on the crown of the head, just keeping the whole top wet with its stream. We saw two under this operation, and several others came in while we remained, to place their children in a similar way. Males and females are equally used thus, and their sleep seemed sound and unruffled.

"The mode, too, of lulling asleep was singular: seizing the infant with both arms, with these, aided by the knee, they gave it a violent rotatory motion, that seemed rather calculated to shake the child to pieces than to produce the soft effect of slumber. It was, however, unerring in its effects. One of the children was intently looking at the strangers, and eyeing the dresses and arms with every symptom of strong curiosity and excitement; no signs of drowsiness could be traced, yet the vigorous operation admitted of no pause; its eyes gradually closed, and in 30 seconds it was fast asleep.

"On inquiry, we found that this singular process for sleeping, and bathing the children, is universally used throughout the hills, where there is the means of using it, under a notion that it is very salutary to keep the head cool, and that it increases hardihood and strength."—p. 105.

Near Prospect of the Himalaya Range.

"Such was the slope, but steep and interrupted with fallen trees, over which we reached the pass between the two peaks of the Urructa Mountain, whence looking to the northward, the whole stupendous range of the Himala burst upon our view, now no longer fading into distance, but clear and well defined. Bright with snow, and rising far above all intervening obstacles, they stretched, bounding our view, from far beyond the Sutlej, till our sight was interrupted where in all probability the hills of Gungootree and Buddrinaath arose.—The day was clear, and only here and there a black cloud rested on the highest peaks. The scene was majestic, and, if the epithet can justly be applied to any thing on earth, truly sublime.

"There is that in the appearance of the Himala Range, which every person who has seen them will allow to be peculiarly their own. No other mountains that I have ever seen have any resemblance to their character. Their summits shoot in the most fantastic and spiring peaks, to a height that astonishes, and when seen from an elevated situation, almost induces the belief of an ocular deception. The very lofty and shaggy ranges which are thrown out from their feet, up towards that on which we stood, shrunk into petty hills in their presence. Unless, howe[illegible]ng approaching to them in its nature has been see[illegible]matter to form or to give an idea of the striking [illegible]hich they present, seen as we now saw them. It will be best attempted by the drawings which delineate the scenery."—P. 159.

Description of the Himalayan Range, and the Passes across it.

"The great Himalayan snowy range is only the highly elevated crest of the mountainous tract that divides the plains of Hindostan from those of Thibet or Lesser Tartary. Far as they predominate over, and precipitously as they rear themselves above the rest, all the hills that appear in distinct ranges, when viewed from the plains, are indeed only the roots and branches of this great stem, and however difficult to trace the connection, can always be detected between each inferior mountain, and some particular member of its great origin. At times indeed, this connection seems nearly broken; and a lofty peak, rearing itself as if in rivalry, presents a very extensive ramification of lesser ridges, separating ravines which extend down to the great drains of the country, and thus becomes, as it were, the nucleus of a subordinate district; from the lofty height of which, the country between it and the principal chain seems comparatively low, though very rugged; and in this hollow generally lies some river, with its subsidiary streams, which drain a large portion of the snow that annually melts from their sides. All the regularity of ranges which deceive the eye, on viewing this mountainous belt from the distant plains, thus vanishes on entering the country; and the whole becomes a confused and chaotic assemblage of most rugged mountains, huddled into masses and peaks, and running into ridges, which defy arrangement; and it is only by attentive observation that they can be traced to one or other of the mighty piles that compose the snowy range.

"The horizontal depth of this mountainous tract, on that side which overlooks Hindostan, is no doubt various; but from the difficulty of the country, the traveller performs a journey of many days before he reaches the foot of the immediate snowy cliffs. The best observations do not authorise more than an average of 60 miles from the plains to the commencement of these. The breadth of the snowy zone itself, in all probability, varies still more; for huge masses advance in some places into the lower districts, and in others the crest recedes in long ravines, that are the beds of torrents, while behind they are closed by a succession of the loftier cliffs. Every account we receive of a passage through them, gives a detail of many days journey, through deserts of snow and rocks; and it is to be inferred, that on the N. E. side they advance to, and retreat from the low ground in an equally irregular manner. Indeed some accounts would induce the belief, that long ranges crowned with snow-clad peaks, project in various places from the great spire, and include habitable and milder districts; for in all the routes of which we have accounts, hills covered with snow are occasionally mentioned as occurring, even after the great deserts are passed, and the grazing country entered. The breadth, then, of this crest of snow-clad rock itself cannot fairly be estimated at less than from 70 to 80 miles. * * *

"Various sources of information lead us to presume a pretty extensive detail of hills beyond the loftiest belt, that by no means terminate even at Gara or Gartope, though they do not reach the height of these to the W. and S. W. A branch of the Cailas range, undoubtedly a ramification of the Himala, stretches out beyond the lake Mansrowar, a considerable way towards Gartope. The general character of the hills on the N. E. side of the Himala, if we may judge from information, seems somewhat less rugged and unhospitable than those on the S. W. face. * * * *

"The great snowy belt, although its loftiest crest is broken into numberless cliffs and ravines, nevertheless presents a barrier perfectly impracticable, except in those places where hollows that become the beds of rivers have in some degree intersected it, and facilitated approach to its more remote recesses. Few rivers hold their course wholly through it; indeed, in the upper part, the Sutlej alone has been traced across this rocky barrier, and there is a path along its stream, from different parts of which roads diverge, that lead in various directions through the mountains. No reasonable doubt can now exist of the very long and extraordinary course which that river takes. The routes giv [illegible] will trace it particularly, nearly to its origin. Severa [illegible] through the Himala exist to the south-eastward [illegible] cquainted with all of them beyond Kumaoon [illegible] and that of the Sutlej the passes of Joar, Darma, Nitteemana, Lamanittee, Guroonettee and Birjee are found practicable for the conveyance of goods. * * * *

" Beside these chief passes, there are others of more danger and difficulty that pervade the snowy range in various directions, finding outlets to the milder countries beyond. Such is the pass near the source of the river J'pannevie, that from Bhurassoo to the neighbouring districts of China; a path also said to exist near Kedarnauth, &c. &c. These are all so dangerous and toilsome, that few but the wildest inhabitants of the most inhospitable regions choose to invade their deserts of eternal rock and snow, where no living thing is seen, and no means are to be obtained for long preserving life. To the westward of the Sutlej, the passes are perhaps more frequent, certainly less difficult. The pass of Cooloo through Stanpore, by Lucktote to Gara and Ludhak, and that through Chumbee by Joocela, Mookhee, and Htoorpore, are among the best and most frequented. With those which may exist farther to the westward between Chambee and Cashmire, I am unacquainted; but it is well known that a comparatively easy and much frequented road is found from the Punjab to Cashmire, and through that valley to Ludhak, and the other states and districts of Thibet. I am unacquainted, even by information, with the actual course through the hills to Cashmire, but it doubtless leads along the river Jy,thure, which arises in the hills bounding that valley to the north-east and east."

On the Limit of Perpetual Congelation in the Himalaya Range.

The Limit of Perpetual Congelation in the Himalaya Mountains, has been a matter of some controversy. A learned writer in the Quarterly Review has asserted, that this height is *below* 11,000 feet above the sea, and has maintained that the height of the range itself will be found much inferior to that of the Andes. Captain Webb, from numerous heights taken with the barometer, has drawn a very different conclusion.

" Near the Temple of Milum, (says Mr Fraser,) elevated 11,405 feet, there were large fields of oe or rye, and buckwheat, and at an elevation of about 13,000 feet, he procured some plants of spikenard. On the 21st of June, Captain Webb's camp was

11,680 feet above Calcutta. The surface was covered with rich vegetation as high as the knee, very extensive beds of strawberries in full flower, and plenty of currant-bushes in blossom all around, in a clear spot of rich black mould soil, surrounded by a noble forest of pine, oak, and rhododendron. On the 22d of June he reached the top of Pilgoenta-Churhaee, 12,642 feet above Calcutta: There was not the smallest patch of snow near him, and the surface was covered with strawberry plants, butter-cups, dandelion, and a profusion of other flowers. The shoulders of the hill above him, about 450 feet more elevated, were covered with the same to the top, and about 500 feet below was a forest of pine, rhododendron, and birch. * * * These facts lead Captain Webb to infer, that the inferior limit of perpetual congelation in the Himalaya Mountains, is beyond 13,500 feet *at least*, above the level of Calcutta."

These conclusions of Captain Webb receive much support from the following observations of Mr Fraser.

"On the night of the 16th we slept at Bheemkeudar, near the source of the Coonoo and Bheem streams. There is no wood near this place, even in the very bottom of the valley, and we had left even the stunted birch at a considerable distance below; but there was a profusion of flowers, ferns, thistles, &c. and luxuriant pasturage. Captain Webb's limit of wood is at least as high as 12,000 to 12,300 feet. I would therefore presume the site of Bheemkeudar to be considerably above that level, say 13,000 to 13,300 feet above Calcutta. From thence we ascended at first rather gradually, and then very rapidly, till we left all luxuriant vegetation, and entered the region of striped and scattered, and partially melting snow, for nearly two miles of the perambulator. From calculating the distance passed, and adverting to the elevation we had attained, I would presume that this was at least 1500 feet above Bheemkeudar, or from 14,500 to 15,000 feet above Calcutta.

"We proceeded onwards, ascending very rapidly, while vegetation dec [illegible] radually to a mere green moss, with here and there a fe [illegible] starting through it; snow fast increasing, till a [illegible] red on what I presume was the perennial and unmelting snow entirely beyond the line of vegetation, where the rock was bare even of lichens." P. 327.

From these and other facts which Mr Fraser details, he considers the line of perpetual congelation as between 15,000 and 16,000 feet above Calcutta.

Account of Jumnotree, the Source of the Jumna.

"The spot which obtains the name of Jumnotree is very little below the place where the various small streams formed on the mountain's brow by the melting of many masses of snow, unite in one, and fall into a basin below. To this basin, however, there is no access, for immediately above this spot the rocks again close over the stream, and though not so lofty as those below, they interpose a complete bar to further progress in the bed of the torrent. A mass of snow, too, had fallen from above at the farther extremity of this pass, under which the river runs. Between the two banks the view is closed by the breast of the mountain, which is of vivid green, from perpetual moisture, and is furrowed by time and the torrents into numberless ravines, and down these ravines are seen trickling the numerous sources of this branch of the Jumna. Above this green bank, rugged, bare, and dark rocky cliffs arise, and the deep calm beds and cliffs of snow towering above all, finish the picture. Noble rocks of varied hues and forms, crowned with luxuriant dark foliage, and the stream foaming from rock to rock, form a foreground not unworthy of it.

"At the place where it is customary to perform ablution, the rock on the N. E. side of the river is very steep. Between the laminæ of this rock, which appears to be quartzose, run several small streams of warm water, forming together a considerable quantity. There are several other sources, and one in particular, from which springs a column of very considerable size, is situate in the bed of the river between two large stones, and over it falls a stream of the river water. This water is hotter than that already noticed; the hand cannot bear to be kept a moment in it, and it emits much vapour. These warm springs are of great sanctity; and the spot for bathing is at that point before mentioned, where one of a considerable size rises in a pool of the cold river water, and renders it milk warm. This jet is both heard and seen as it plays under the surface of the pool. * * * Here all the people bathed, while the pundit said prayers, and received his dues; and here also I bathed, was prayed over, and submitted to be marked by the sacred mud of the hot springs on the forehead like the rest, and of course was obliged to make my present to the priest for his ministry." P. 429.

Account of Gungootree, or the Source of the Ganges.

" Below Goureecounda, the river falls over a rock of considerable height in its bed, and continues tumbling over a succession of petty cascades or rapids nearly the whole way to Mianee-ke-Gad,h. Above the debouche of the Ked or Gunga, the bed widens into a small shingly space, in which the river rapidly rolls. Just at the gorge of this space, a bridge has been thrown across, which is formed of two parts, the interior ends of the beams resting on a large rock in the centre; and just above the bridge, in a bay formed by a neck of the river in this shingly space, fifteen feet above the stream, is situated the small temple or mut dedicated to the goddess Gunga or Bhagiruttee.

" In former times no temple made with hands was provided for the worship of the deity; but within these few years Ummer Sing T,happa, the chief of the Goorkha conquerors, appropriated 400 or 500 rupees for the erection of the small building which is now placed there. * * * The temple is situated precisely on the sacred stone on which Bhagiruttee used to worship Mahadeo, and is a small building of a square shape, for about 12 feet high, and rounding in, in the usual form of pagodas, to the top. It is quite plain, painted white, with red mouldings, and surmounted with the usual melon shaped ornaments of those buildings. From the eastern face of the square, which is turned nearly to the sacred road, there is a small projection covered with a stone roof, in which is the entrance facing the east; and just opposite to this, there is a small pagoda-shaped temple to Bhyramjee. The whole is surrounded by a wall of unhewn stone and lime, and the space this contains is paved with flat stones. In this space, too, there is a comfortable but small house for the residence of the brahmins who come to officiate. Without the enclosure, there are two or three sheds constructed of wood, called *Dhurm sullahs*, built for the accommodation of pilgrims who resort here; and there are many caves around, formed by overhanging stones, which yield shelter to those who cannot find accommodation in the sheds.

"The scene in which this holy place is situated, is worthy of the mysterious sanctity attributed to it, and the reverence with which it is regarded. We have not here the confined gloominess of Bhyram Gattee: the actual dread which cannot but be inspired by the precipices and torrents and perils of the place, here gives way to a sensation of awe, imposing but not embarrassing, that might be compared to the dark and dangerous pass to the centre of the ruins of a former world; for most truly there is little here that recalls the recollection of that which we seem to have quitted. The bare and peaked cliffs which shoot to the skies, yield not in ruggedness and elevation to any that we have seen: the ruins lie in wild chaotic masses at their feet, and scantier wood imperfectly relieves their nakedness; even the dark pine more rarely roots itself in the deep chasms which time has worn. Thus on all sides is the prospect closed, except in front to the eastward; where, from behind a mass of bare spires, four huge lofty snowy peaks arise: these are the peaks of Roodroo-Himala. There could be no finer finishing—no grander close to such a scene.

"We approach it through a labyrinth of enormous shapeless masses of granite, which during ages have fallen from the cliffs above, that frown over the very temple, and, in all probability, will some day themselves descend in ruins and crush it. Round the enclosure, and among these masses, for some distance up the mountains, a few fine old pine-trees throw a dark shade, and form a magnificent fore-ground; while the river runs impetuously in its shingly bed, and the stifled but fearful sound of the stones which it rolls along with it, crushing together, mixes with the roar of its water.

"It is easy to write of rocks and wilds, of torrents and precipices; it is easy to tell of the awe such scenes inspire: But it is not so simple, to many surely not very possible, to convey an adequate idea of the stern and rugged majesty of some scenes; to paint their lonely desertness, or describe the undefineable sensation of reverence and dread that steals over the mind, while contemplating the deathlike ghastly calm that is shed over them. Surely such a scene is Gangootree. We were now in the centre of the stupendous Himala, the loftiest, and perhaps most rugged, range of mountains in the world. We were at the acknowledged source of that noble river, equally an object of veneration and a source of fertility, plenty, and opulence to Hindostan; and we had now reached the holiest shrine of Hindoo worship which these holy hills contain. The fortuitous circumstance of being the first European that ever penetrated to this spot was no matter of boast, for no great danger had been braved, and no extraordinary fatigue undergone.

The first object of inquiry that naturally occurs to the traveller, is the source of the river. This source, according to the pundit's report, is not more than five miles horizontal distance from the temple, and in a direction S. E. 85° nearly; and beyond this place, it is, in all probability, chiefly supplied by the melting of the great bosom of snow which terminates the valley, and which lies between the peaks of the great mountain above mentioned.

"The mountain which is considered to be the loftiest and greatest of the snowy range in this quarter, and probably yields to none in the whole Himalaya, obtains the name of Roodroo-Himala, and is held to be the throne or residence of Mahadeo himself. It has five principal peaks, called Roodroo-Himala, Burrumpooree, Bissenpooree, Oodgurreekanta, and Soorga Rounee. These form a sort of semicircular hollow of very considerable extent, filled with eternal snow; from the gradual dissolution of the lower parts of which the principal part of the stream is generated: probably there may be smaller hollows beyond the point to the right above Gangootree which also supply a portion." P. 471.

ART. III.—*On the Deoxidation and Reduction of Iron Ores.* By DAVID MUSHET, Esq. Communicated by the Author.

MANY years ago I was led, from various experiments (which were then nar[illegible] Philosophical Magazine,) to conclude, that th[illegible]laceous ironstone of this country, was a mixture of the oxide of iron with various earths, chiefly clay, lime, and silex.

Some time since there appeared in Dr Thomson's Annals of Philosophy, the analysis of an ironstone, wherein it was stated, that the iron did not exist in the state of an oxide, but in that of either a carbonate or a hydrate. As I write from recollection, and cannot réfer to the work, I am uncertain which, nor is it at all material, as the facts I wish to investigate are these, first, Whether the iron contained in the ironstone so universally diffused over this country, does or does not exist in the state of an oxide? and, subsequently, if it do so, to establish the extent of the oxidizement.

I think Dr Thomson and most others who have examined the deep red-coloured ores of Cumberland and Lancashire, have agreed that these are oxides of iron, and, as far as my own experiments go, there can be no doubt on the subject. If these ores are compared with the common ironstone before burning, no two substances of the same class can appear more dissimilar, and after making a considerable allowance for the widely different proportions of iron in each, the examiner feels inclined to assign to it a very different state of existence. This striking contrast, however, is materially lessened when the ironstone has been exposed to the fire; it then passes from a greyish or blackish-blue, (its native colour,) and assumes various shades of brown, red or purple, the intensity of which depends on the quantity of iron present, the administration of the dose of heat, and the length of the exposure.

The art of roasting ironstone (technically called its Calcination,) has by some been considered as an operation in which, for the first time, the ironstone unites with a portion of oxygen, and in so far as this requires to be again removed in the smelting furnace, previous to separation, it has been deprecated or thought unnecessary. Practice, however, has more clearly in this, than in any other metallurgical operation, determined the utility and necessity of roasting the ores, previous to their being smelted.

After considering the subject again, and referring to many other experiments, I remain still of my former opinion, that the common ironstone of this country has united with its iron nearly 40 *per cent.* of oxygen, nor have I been able to satisfy myself that ironstone properly roasted, unites in the slightest degree with oxygen, though there is no doubt but that long exposure and high temperature, will cause such a combination, though to a limited extent. I hope, therefore, you will indulge me with room for the insertion of some experiments and remarks on the roasting, deoxidation, and reduction of ironstones, tending to elucidate the subject.

Ironstones in general in roasting, lose from 30 to 35 *per cent.* of their weight. Torrefaction commences with a change of colour upon the surface, which keeps penetrating as the process advances. When the ironstone is of one uniform colour throughout, the operation may then be considered as perfect; if a mass of the ironstone be broken in the interim, the unroasted part will be found occupying the centre, and of a blackish colour. Some hours are necessary to roast thoroughly, even a small piece of ironstone; the same effects, however, may be produced in two minutes, by exposing ironstone finely pounded, upon a red-hot plate. The change of colour in this case is rapid; it almost instantly becomes brown, then black, though in cooling it usually returns to a brownish red, or dirty purple colour.

An ironstone that had lost 32 *per cent.* in roasting, was pounded very small, fused, and yielded as follows:

400 grains of ironstone, 50 grains of finely pulverised coke,	139 grains of iron, = 33½ *per cent.*
300 grains of ironstone, 60 ditto of coke,	123 grains of iron, = 41½ *per cent.*
300 grains of ironstone 75 ditto of coke,	132 grains of iron, = 44 *per cent.*

The last reduction may be considered as nearly a perfect assay of the ore, which, in many cases, where the earthy matters are nearly in equal proportions, may be accurately performed without the addition of any flux.

Some masses of the same substance not previously roasted, weighing 6024 grains, were put into a crucible along with coke-dust, and a pyrometer roll fitted at 1°. After an exposure of ten hours to a bright heat, the pyrometer was found to indicate 28°, and the ironstone had lost in weight 42 *per cent.* or 10 *per cent.* more, than when roasted in the common way. This I attributed to the loss of oxygen, in consequence of the metallic particles being exposed in contact with carbonaceous matter. The ironstone, when washed, and perfectly freed from this substance, was of a greyish-blue colour, adhesive to the tongue, possessed of a metallic taste, and when pulverised, deflagrated in flame.

400 grains of the common roasted ironstone, for the sake of comparison, were fused alone, and afforded a dense, shining, opaque glass, without any metallic separation.

400 grains of the cemented deoxidated ore were reduced to the same size, and fused under the same circumstances, from which resulted a prismatic coloured button of iron, weighing 120 grs., or 30 *per cent.* The marked difference between these two results I also attributed to the presence and absence of oxygen in the two ores.

In another experiment, I find that 4281 grs. of the same ironstone in pieces, were exposed for twenty-four hours in contact with coke-dust, to a heat, that, by the pyrometer, indicated 69° of Wedgwood: loss in weight equal to 43 *per cent.*, so that fourteen hours of longer exposure and double the temperature, had only produced a further deoxidation of 1 *per cent.* beyond that obtained in the first cementation. The pieces of ironstone were now completely metallic, compact, and brightened under the file.

300 grains of this deoxidated ironstone, yielded by fusion *per se*, a mass of soft malleable iron, weighing 113 grains, or 37⅔ *per cent.*

300 grains, to which were added 15 of coke-dust, yielded by fusion 163 of iron, or 54⅓ *per cent.*; 5 grains of coke were found in the crucible unacted upon, so that 10 grains of coke were employed in reviving the additional 50 grains of iron.

200 grains of roasted ironstone were fused *per se* in a black lead crucible; 49 grains of iron, or 24½ *per cent.* was the result.

200 grains of ironstone, deoxidated at 69°, were similarly exposed, and fused, from which resulted 92 grains of iron, or 46 *per cent.*

These details, I think, clearly shew, that there is some ponderable matter in the ironstone after roasting, which is removed, by heating it in contact with carbonaceous matter, and which, in the after fusion, affords a very striking and very different result. I am aware that it may be urged, that this ponderable matter may not have previously existed in the ironstone, but have become united to it in the process of roasting; and that the contrast in the above experiment, to have been more complete, ought to have been made with the ironstone in its raw or native state. In answer to this, I have, in the first place, to remark, that no reliance can be placed on experiments made with raw ironstones, and carbonaceous matter, reduced to the necessary degree of fineness: The instantaneous expulsion of 30 *per cent.* of volatile matter, occasions such an agitation in the crucible, that part of the ore and carbon is unavoidably lost. In the second place, I submit, that it is exceedingly improbable, in an operation which may be performed in two minutes, in a heat which would not raise the slightest scale of oxide upon pure malleable iron, that any combination of oxygen can take place with iron not in a metallic state, the particles of which are more or less sheltered, by the presence of a quantity of earthy matter, equal to that of the metal.

The ironstone subjected to the foregoing experiments, when roasted, yielded 44 *per cent.* of iron, and lost in roasting 32 *per cent.*, so that the ore in its native state contained 33 *per cent.* of iron. After the rate of 40 *per cent.*, this would furnish us with a quantity of oxygen equal to 13.2 *per cent.*, united originally with the iron. Now, the ponderable matter got rid of by the cementation, in the experiment at 28° of Wedgwood, was the difference between 32 and 42, or 10, and in that of 69°, the difference was equal to 11°; a coincidence sufficiently near to warrant the conclusion, that the iron of our ironstone is not only in the state of an oxide, but that the dose amounts to 40 *per cent.* at least; for it cannot for a moment be supposed, that any process of cementation confined to an inferior range of temperature, could separate from the ore the last portions of oxygen, which it is even probable resist the higher temperature, and more perfect operation of the smelting furnace.

That a gr [illegible] is removed in a smelting temperature, is proved by [illegible]xperiments:

934 grain[illegible]e in pieces, were placed in contact with pounde[illegible]od, and exposed for four hours to

a cementing heat of 40°, which was then gradually increased to 120°, at which it remained for nearly eight hours. The result was a complete separation of the iron and earthy matters from each other, in the shape of globules; the former in the state of grey crude iron, the latter in that of glass possessed of some transparency. They weighed collectively 484 grains, the loss 450 grains, being equal to 48.19 *per cent.* If 32 is taken from this, being the loss sustained in the operation of roasting, the quantity of matter removed by the cementation will be 16.19; so that in these three experiments by deoxidation, the loss in weight has been analogous to the temperature, viz.

In 28° of Wedgwood,	loss	42 *per cent.*
In 69°	ditto,	43
In 120°	ditto,	48.19.

And the quantities of oxygen passed off in the state of carbonic acid or carbonous oxide, will be represented by the numbers 10, 11, 16, 19.

Having arrived at similar conclusions in experiments by deoxidation with roasted ironstones, I insert the following as illustrative of this coincidence.

Some pieces of ironstone that had lost in roasting 29 *per cent.*, were exposed for fourteen hours to a heat increasing to 120° of Wedgwood, at which it was stationary for several hours.

The ironstone originally weighed - -			749 grains.
After cementation, it was found resolved into			
Grey cast-iron globules, - -		375 grains.	
Glass globules, - - -		217	
		———	592
			———
Loss in oxygen - - - -	20.9		Loss 157
Iron obtained - - - -	50.0		
Glass, very transparent, - -	29.1		
	———		
	100.0		

This experiment was repeated, subjected to a longer but inferior temperature. The quantity of volatile matter lost, was 20.6 *per cent.* A few small globules of cast-iron had exuded, and appeared upon the surface of the masses; but no separation had taken place between the iron and the earthy matter. In both these experiments 41 *per cent.* of oxygen seems to have been removed from the ore.

Having thus, as I conceive, rendered it exceedingly probable that the iron of the common ironstones of this country, either in their native or roasted states, is united with nearly 40 *per cent.* of oxygen, I shall conclude this paper with the result of some similar experiments with Lancashire ore, which also seem to prove that the iron of these ores is not united to a greater dose of oxygen than the common ironstone, though their intense red colour, in the first instance, leads to a different conclusion.

Lancashire ore, when reduced to a small size, and heated on an iron-plate till it becomes of a black colour, loses only from 4 to 5 *per cent.* of its weight; (ironstone in the same time would lose from 25 to 35 *per cent.*,): as the ore cools the black passes off, and the native red colour returns. In this state it has acquired a slight, though perceptible, obedience to the magnet. If the ore is heated for two hours, it loses in all from 6 to 7 *per cent.*, and is then strongly magnetic, rendering it probable that the magnetic force in this case is more the result of a new arrangement of the metallic particles, than of the expulsion of so small a quantity of water.

If the exposure of this ore be still further continued, and particularly with an increase of temperature, it will acquire its lost weight, assume a vitreous sort of fracture, and lose its obedience to the magnet; such increase of weight being undoubtedly owing to a further dose of oxygen uniting with the iron, which I have never found to exceed that of the water expelled in the more moderate temperature; and it may sometimes happen in experiments of this nature, that the ore, after being roasted for eight or ten hours, will weigh as much as when first introduced into the furnace, though, had it retired at an earlier stage of the operation, the deficiency of weight would have been as before stated.

In general, when Lancashire ores (according to the sort,) are cemented in contact with carbonaceous matter, a loss of weight is sustained of from 25 to 35 *per cent.*, from which is to be deducted that weight, consisting of water, which the ore would have lost by being exposed to a low red heat, leaving the difference to express the quantity of oxygen removed from the ore during the operation. The following may be considered as a near approach to the constituent parts of the richest and densest species of the Lancashire hematites.

Iron, - -	64.0
Oxygen united with iron,	24.5
Earthy matter, -	5.0
Water, - - -	6.5
	100.0

The proportion of oxygen united in this analysis, is under 40 *per cent.*

I shall feel much gratified if these remarks lead to farther investigation; so that those who are interested in the subject, may not only be furnished with an accurate result, but also with a method by which the same may be definitively ascertained.

ART. IV.—*Observations on Ice-Bergs, made during a short Excursion in Spitzbergen.* By THOMAS A. LATTA, M.D.

THE interest which of late years has been excited by the Northern Regions, renders every communication concerning them important, which may contain any thing like information. Though those by whom these communications are made, may be but young in science, yet the facts which have come under their own observation, may not be altogether unworthy of notice. From the high rank which Captain Scoresby holds in the literary world, from his intimate acquaintance with the Arctic Seas, and after the works he has published on the phenomena these present, it may seem presumptuous for an unknown individual to obtrude himself on the public, and to pretend either to question the opinions of that enlightened navigator, or to state facts which may have escaped his observation. As both these, however, may be done in perfect consistency with the high respect I cherish for the distinguished talents of Captain Scoresby, I shall take the liberty to state some facts concerning the ice-bergs of Spitzbergen, which I had the opportunity of personally observing.

I had the honour to be appointed his surgeon and companion for 1818, in a voyage to the Arctic Ocean. Towards the end of July, finding no object more worthy of our attention, we directed our course to the north-west shore of Spitzbergen. Among our excursions on the coast of that island, we visited the ice-bergs. Having manned two boats, we directed our course to that part of the shore where the Seven Ice-bergs of navigators are situated. These, however, presenting nothing novel to our Captain, after viewing the frightful precipice which terminates the seaward extremity of one of the principal masses, he returned to the ship. I, with the remaining boat, landed a little to the south of this ice-berg, and having shot a few birds, and collected some plants and minerals, the natural productions of the beach, I sent the boat round to meet me at the north side, and made preparations to cross the berg, which lies from east to west; one of the sailors accompanied me, and, both armed with muskets loaded with ball, we commenced our journey.

Captain Scoresby remarks, that "the upper surfaces of these ice-bergs is generally concave." The notice of the stranger is very soon attracted by the convexity of all that portion of the ice-berg which lies under the summer snow-line, which may extend a league or so from the shore. This convexity gradually becomes less obvious as the mass extends inland, till, among the higher lands in the interior, it becomes concave. Where the ice-berg is limited by the mountains below the snow-line, it is very steep on both sides; but, from the roughness of the surface, our ascent was rendered easy. It may be difficult to account for this abruptness, which is well marked on both sides of the mass. I think, from its being only found below the snow-line, that the bare mould on the mountain's side, destitute of its reflecting surface, had imbibed so much caloric from the sun's rays, as, partly by heating the atmosphere in the vicinity, partly by radiation, to prove sufficient to melt the adjacent ice, and thus assist another cause, afterwa [illegible] noticed, in rendering the ice-berg convex.

Having go [illegible] horizontal surface, we soon found more formidal [illegible] ncounter, the ice being traversed in every direction with rents, increasing in number and magnitude as we approached the middle. These measured from a few inches to several yards in width, and in general terminated sooner or later in each other. The ice being rough, we could, without danger, approach the edge of these chasms, which present a terrific aspect. Their blue edges gradually became darker, till they reached a depth where the most wandering sun-beam cannot reach; and here and there the gurgling of a subglacial rill, added to the romantic nature of the scene.

Captain Scoresby, speaking of these rents, says, "The surface was very uneven, being furrowed and cracked all over; this roughness appeared to be occasioned by the melting of the snow, some streams of water being seen running over the surface; others, having worn away the superficial ice, could be still heard pursuing their course through subglacial channels to the front of the ice-berg, where, in transparent streams or small cascades, they fell into the sea. In some places, chasms of several yards in width were seen, in others they were only a few inches or feet across." The following considerations incline me to doubt the accuracy of this explanation.

1*st*, Though this was the warmest season of the year, the thermometer varying between 36° and 45° of Fahrenheit, I found not so much water on its surface as to quench my intolerable thirst, being obliged from time to time to have recourse to a *bolus* of ice or snow to satisfy this unpleasant sensation.

2*dly*, If such rents were produced by water, it must have required a much greater inundation than such a limited space among the mountains on the north-west coast of Spitzbergen could have afforded, where ice and snow melt very tardily.

3*dly*, These rents extend up to, and, in all probability, beyond the snow-line, undiminished in dimensions, where the temperature never falls below the freezing point. Whence was the water furnished to produce rents here?

4*thly*, If they had been formed by water, would they not have followed the declivity, and, like a river's bed, have had their width and depth increased with their course? Far otherwise, however, is the case, for they run in every possible direction, some wider in the centre, and gradually closing towards the extremities. I heard indeed the noise of water in a few, but the trickling sound indicated its being but sparing in quantity.

5thly, Some of the rents had a drift of snow thrown across their mouths, or, as the Captain remarks, "were filled with it to the general level." I should suppose this would have been the first to have suffered from the solvent or abrasive power of the water, had the chasms been produced through the influence of that fluid.

I am inclined to look for the real cause of these rents in the expansive power of water, when subjected to the freezing process. Suppose the ice-berg to be in its infancy, and but a few feet thick, the heat of summer will render it spongy and hollow; here and there its under surface will be furrowed with streamlets passing over its bed; all these vacancies will be occupied by water. On the return of winter, by the expansive power exerted by the water, when its particles assume an arrangement for the formation of ice, the walls of the cavities will be forced asunder, and a partial rent formed. Into these rents water will flow, which also becoming solid, will exert a still more powerful force, enlarging the rents, extending them in length, width and depth; whilst the damming up and freezing of the little streams below, will assist the action by elevating the mass from its bed. This process annually repeated, might induce the appearance now presented by the ice-bergs; and being wedged in between mountains, they cannot extend laterally, and necessarily become arched or convex, impelled, as it were, by a central force in the expansion of water.

After contemplating the magnificence of these chasms, we made all possible speed to gain the northern boundary of the ice-berg, though not without difficulty and danger. We were often obliged to retrace our steps, or deviate considerably from our course, the chinks being too wide to admit of our leaping across. Some of these were rendered particularly dangerous, from the drifted snow covering their mouths proving too weak to support the [illegible]ht of the body. In one of these, in attempting to [illegible] ice-berg, I imprudently stept into a narrow chas[illegible]ow to the general level; and immediately pl[illegible] shoulders, and might, but for the sudden e[illegible] arms, have been buried in the gulf. My imprudence here originated, in finding many of these coverings sufficiently strong to sustain the weight of my body; and expecting to find here the same firmness of constitution as in others, I was tempted, by way of preventing a circuitous route, to cross this, which was but a thin cake of snow laid over an unfathomable gulf, an attempt which had nearly proved fatal. The situation of a rent covered with snow, could, in general, easily be discovered, being whiter than the rest, though sometimes we had not this criterion to be directed by, as we had sometimes to cross considerable patches of snow. Proceeding with much caution, we arrived in safety at the north side of the berg, where the boat had been waiting our arrival.

I consider the breadth of this extraordinary accumulation to exceed an English mile; its extent inland was hid under the common covering of snow.

Having got into the boat, we proceeded along the front of the icy cliff, which rises from 150 to 200 feet above the level of the sea. This, from the agitation of the water, was undermined to a considerable extent, which receiving the break of a heavy swell, produced a noise like distant thunder, occasioned by the reverberation through its numerous caverns.

I was once inclined to consider these ice-bergs as conical, with their base towards the sea, whilst their apex rested on the mountains in the back ground; and was of the same mind with Captain Scoresby, conceiving them as limited on three sides by mountains, and on a fourth by the sea. But whilst rambling on the shores of Spitzbergen, and viewing the coast from the summit of a lofty mountain, circumstances came under my observation, which led me to consider this as rather an unfit situation for the formation of an ice-berg, for by far the greater number of such valleys are entirely destitute of such formations; and when these occur, they precisely occupy the place which might have been occupied by rivulets. These, no doubt, must have been but sparingly supplied with water; in such quantities, however, as in process of time to prove sufficient to form ice-bergs. They might have received water during the colder seasons of the year from internal sources, derived from imbibed water from snow or ice melted, whilst the heat of summer prevailed. The rivulet, when the temperature descended below the freezing point, would soon be frozen to the bottom, whilst the sources of water, unaltered in temperature, issuing as springs from the sides and bases of the mountains, continuing to flow, would augment the mass by repeated layers, in proportion and extent to the quantity of water poured out. From this view I am disposed to think, that these ice-bergs are much more extensive than is imagined, and that they follow the course of the valley into the interior. I do not agree in opinion with Captain Scoresby on the increase of bulk of these ice-bergs. "Ice-bergs," says he, "are as permanent as the rocks on which they rest; for though large portions may be frequently separated from the *lower edge*, or *by avalanches from the mountain summit* be hurled into the sea, yet the annual growth replenishes the loss; and probably, on the whole, produces a perpetual increase. But the annual supply of ice is not only added to the upper part, but also to the *precipitous crest facing the sea*, which addition being run into, or suspended over the ocean, admits of new fragments being detached, and of the renewal of the vitreous surface which it presents to the eye after each separation. In some places, indeed, where the sea is almost perpetually covered with ice, the berg or glacier makes its way to a great extent into the sea, till it reaches a depth of several hundreds of feet." I think all that part of the ice-berg which lies beyond a league or so from the shore, has long ago ceased to receive additions of ice, as it is now much elevated above the circle of perpetual congelation, being buried under a great body of snow. At the seaward extremity, where, from the influence of the ocean, the snow-line is more elevated, the annual augmentation will be but very scanty, for, being convex, it cannot command the mountain's rills; and whatever water arises from the melting of the snow on the surface, will naturally be carried off by the chinks, so that all its supply will depend on the half dissolved snow retaining water among its particles afterwards to be frozen, or on the deposition of hoar-froast, which envelopes the whole island in spring. In this way the effects of summer may be counteracted: And if a[illegible]made, it is only to the upper surface; for so far f[illegible]ce gaining ground on the sea, I think it is annu[illegible]se. The west coast of Spitzbergen is very bold, and has been evidently encroached on by the ocean, which washes even the foot of its mountains. The ice-bergs, like the circumjacent coast, seem incapable to resist the fury of the waves. Captain Scoresby states a fact in his Essay on Ice-Bergs, in the Fourth Number of this Journal, which is against the probability of the precipitous crest facing the sea gaining ground; for he remarks, "The front of each ice-berg varies from 400 to 500 feet in height above the level of the ocean, lies parallel with the shore, and is generally washed by the sea." Surely they would not all have their boundaries limited by the shore. Some would have made greater progress, and long ere now encroached on the empire of the waves.

The general appearance of this ice-berg corresponds with all we saw, which were more than seven in number. They all occupied valleys. The hills on either side measured from 700 to 1200 feet above the level of the sea. Ice-bergs are composed of fresh-water; they have a bluish green colour, owing to the obstruction and reflection of the more refrangible of the rays of light. When seen floating in small masses, they seem quite black, for then being in little pieces, and quite transparent, all the rays of light are transmitted.—After contemplating these grand objects, I returned to the ship, highly gratified with the magnificence of the scene.

ART. V.—*On the Phenomena of Dichroism, or the Absorption of Common Light by Crystallised Bodies.* By DAVID BREWSTER, LL. D. F. R. S. Lond. and Sec. R. S. Edin.

IN the course of the experiments on the absorption of polarised light, of which an abstract was given in the last number of this Journal, I had occasion to investigate the law of a very interesting class of phenomena, which appeared by the transmission of *common light* in different directions through crystallised bodies. Cordier, when he discovered the Dichroite, observed the two colours of the light which it transmitted in different directions, and gave it the name of *Dichroite*, (from δυο *two*, and χροα *colour)*, on the presumption that nature had confined to this mineral the property of giving two colours. The Count de Bournon (*Catalogue*, p. 121.) had observed the double colour in certain small crystals of mica, and the Marquis de Drée had noticed a similar fact in the tourmaline. During the experiments to which I have alluded, I found that *dichroism* was a very common property of crystallised bodies: that it was related to the axes of double refraction, whether the crystal had one or more axes; and that it arose from the absorption of common light, modified by the doubly refracting forces of the crystal.

As the phenomena of *dichroism* are very beautiful, and can be seen without any apparatus, and merely by exposing the crystals to common light, I shall describe the most important facts as they are seen in *Mica*, *Augite*, and *Iolite*.

1. *On the Dichroism of particular Crystals of Mica.*

There are many crystals of mica which exhibit the phenomena of dichroism, but it is only in some of the small hexahedral crystals, which are transparent in a direction perpendicular to the lamina, that they are seen to the greatest perfection.

In one of these crystals, where the inclination of the resultant axes was about 11°, I found that it was highly transparent in a direction coincident with the plane of the laminæ, even at a thickness of $\frac{1}{8}$th of an inch; in this position the extraordinary ray only was transmitted. As the inclination of the ray to the laminæ increased, the intensity of the transmitted light diminished; and in a direction perpendicular to the laminæ, the crystal was perfectly opaque. A candle, whose light was freely transmitted through a thickness of 0.243 of an inch across the faces of the hexagonal prism, was completely invisible through the terminal planes, when the thickness was only 0.040 of an inch. Another crystal which, in one direction, was as transparent as the ordinary specimens of olivine, would not admit, through a thickness of $\frac{1}{10}$th of an inch, a single ray of the meridian sun on the 20th of May, when it passed along the axis of the prism. The ordinary ray, which was entirely lost in one direction [redacted] gradually visible in thin plates, and at last of equal in ray, as the ordinary light formed a greate laminæ.

2. *On the Dichroism of Augite.*

Out of a piece of yellowish-brown augite, without any crystalline form, for which I was indebted to Robert Ferguson, Esq. of Raith, I cut plates with parallel and well polished surfaces. When one of these plates was exposed vertically to common light, the transmitted light had a moderate intensity. When it was inclined *to one side* in the plane of one of its neutral axes, *the light became more and more intense* as the obliquity increased, notwithstanding the increased thickness of the mineral through which the light had to make its way. Upon examining the transmitted light with a prism of calcareous spar, it was found to be all polarised in a plane perpendicular to the plane of inclination.

When the plate was now inclined from this last position, in the opposite direction, but still in the plane of the same neutral axis, the intensity of the light gradually diminished, till, on the other side of the perpendicular, the plate became *absolutely impervious to the strong* rays of the sun. Upon again examining the transmitted light with a prism of calcareous-spar, before the plate had become opaque, the pencil which had formerly vanished now re-appeared, and gradually increased in intensity, becoming more and more *green*, while the other pencil, which became fainter, grew more and more red, till at a very great obliquity, the one pencil became *perfectly green*, and the other *deep blood-red*. By exposing the plate to the polarised light of the sun, the *red* and *green* were alternately absorbed, according to the position of the neutral axis, with respect to the plane of primitive polarisation.

If we now take *two* plates of *Augite*, one of which has been cut from the other, and adjust each of them separately in a position *where the sun's rays are very much enfeebled*; if they are then brought together, without altering the inclination of the incident light, the sun's rays will penetrate through both the crystals, even though the one is turned round before the other, the incidence remaining the same. If, on the contrary, we adjust each of the plates separately, in a position *where the transmitted light is a maximum, and where the eye cannot endure the strength of the solar ray*; and if they are then brought together, so that the planes of incidence are transverse to one another, not a single ray of light will reach the eye. The cause of this is obvious; as the light transmitted through the first plate is all polarised in one plane, it is all absorbed by the second plate, when placed in a transverse position. See *Phil. Trans.* 1813. p. 103. Though this same fact is seen in *Agate*, yet it becomes doubly interesting to observe the light all polarised in one plane, when the transmitted pencil is a maximum.

3. *On the Dichroism of Iolite or Dichroite.*

This curious mineral, called *Iolite* by Haüy, from its bluish-violet colour, crystallises in six or twelve sided prisms, which appear of a *deep blue colour*, when seen along the axis, and of a *yellowish-brown colour*, when seen in a direction perpendicular to the axis. If *a b c d*, Plate IX. Fig. 9. is a section of a prism of Iolite, by a plane passing through the axis of the prism, the transmitted light will be *blue* through the faces *a, b*, and *d c*, and *yellowish brown* through *a d*, *b c*, and in every direction perpendicular to the axis of the prism. If we grind down the angles *a*, *c*, *b*, *d*, so as to replace them with faces *m n*, *m′ n′*, and *o p*, *o′ p′*, inclined 31° 41′ to *a d*, or to the axis of the prism; then if the plane *a b c d* passes through the resultant axes of double refraction, we shall observe, by transmitting polarised light through the crystal in the directions *a c*, *b d*, and subsequently analysing it, a system of rings round each of these axes. The system will exhibit the individual rings very plainly if the crystal is thin; but if it is thick, we shall observe, when the plane *a b c d* is perpendicular to the plane of primitive polarisation, some branches of *blue* and white light, diverging in the form of a cross from the centre of the system of rings, or the poles of no-polarisation, as shewn at *p* and *p′*, Fig. 10. where the shaded branches represent the blue ones. The summits of the blue masses at *p* and *p′* are tipped with purple, and are separated by whitish light in some specimens, and yellowish light in others. The white light becomes more blue from *p* and *p′* to *o*, where is it quite *blue*, and more yellow from *p* and *p* to *c* ar[illegible] where it is completely yellow. When the plane *a b* [illegible] plane of primitive polarisation, the poles *p*, *p′* [illegible] spots of white light, but every where else the li[illegible]e.

In the plane [illegible]). the mineral, when we look through it at common light, exhibits no other colour but yellow, mixed with a small quantity of blue, polarised in an opposite plane. The ordinary image at *c* and *d* is yellowish-brown, and the extraordinary image faint blue, the former acquiring some blue rays, and the latter some yellow ones from *c* and *d* to *a* and *b*, where the difference of colour is still highly marked. From *a* and *b* towards *p* and *p′* the yellow image becomes fainter, till it changes into blue, and the weak blue image is reinforced by other blue rays, till the intensity of the two blue images is nearly equal. The faint blue image increases in intensity as the incident ray approaches from *c* and *d* to *p* and *p′*, and the yellow one acquiring an accession of blue light, becomes bluish-white. From *p* and *p′* to *o*, the ordinary image is whitish, and the other deep blue, but the whiteness gradually diminishes towards *o*, where they are both almost equally blue, the ordinary image being more luminous at *o*. From *a* and *b* to *o*, the yellowish image becomes more blue, and the bluish image also more blue.

The principal axis of Iolite is negative, and its greatest refracted image is purplish blue, while the ordinary or least refracted image is yellowish-brown, passing into one another as above described. The index of the ordinary refraction is about 1.549; and the mineral belongs to the prismatic system of Mohs, though both this mineralogist and M. Haüy place it under the rhomboidal system.

These properties of Iolite are finely seen in two excellent specimens in Mr Allan's cabinet, which I directed to be cut in the manner represented in Fig. 9.

Art. VI.—*On the Thermometer, as an indicator of a Ship's approach to Land or Soundings, with extracts from a Thermometric Journal kept on board the ship Asia of Scarborough, on a Voyage from New Orleans to Gibraltar, in August, September and October* 1818. By Mr Andrew Livingston.

It is now placed beyond dispute, as a matter of fact, that the thermometer indicates the proximity of the shores of the middle part of the coasts of the United States of America; but I am not aware whether any experiments have been made to the northward of 43° 12′, in which latitude the thermometers used by Mr Mason, on board the ship Eliza packet, were unfortunately broken: nor have I heard of any made to the southward of Cape Hatteras anterior to these, of which the results are recorded in the above mentioned journal.

The public, and mariners in particular, owe much on this subject to the labours of Mr Purdy, hydrographer, London, who, in his well arranged memoir, intended to accompany his large chart of the Northern Atlantic, has treated at considerable length those "silent, imperceptible," but dangerous enemies of safe navigation, *currents*, to which he has doubtless directed the attention of many, and put them on their guard against their perilous effects. In the same work, Mr Purdy has also taken notice of the variations of temperature in the water upon the coasts of the United States; and I have reason to believe has induced others as well as myself, to devote some attention to the subject.

My first experiments were made in October 1817, on a voyage from Philadelphia to Kingston, in Jamaica. I began them inside the Capes of the Delaware, (*i. e.* in the Delaware Bay), and continued them to Jamaica; but the journal of my voyage was lost on board a schooner, which upset in March 1818. I well recollect, however, that in the bay, the mercury in a Fahrenheit's thermometer stood at 60° or 61°; about ten or twelve miles outside the capes, it rose to 66°, and afterwards, when we entered into the limits of the gulf stream current, as it sweeps along the American shore, it rose to 78°, from which it did not vary until we passed to the southward of the parallel of Bermuda.

I have heard, but upon vague authority, that some experiments made on and near the bank of soundings to the southwestward of Ireland, exhibited a difference of two degrees of Fahrenheit's scale, between the ocean water and the water on the bank, the latter being of a lower temperature. Many circumstances lead me to incline to the opinion, that to the northward of the Tropic of Cancer, in the Northern Atlantic, the thermometer is an useful indicator of an approach to land. I am, however [illegible] ecommending that implicit confidence should be pla [illegible] hall be happy if my suggestions of the probabilit [illegible] eful should induce others to make the necessary [illegible] ascertain the fact in the various *places* which i [illegible] nvenience.

The thermometrical journal from which the subsequent table is extracted, was commenced at New Orleans on the 15th August 1818, but I had previously kept memoranda of the greatest rise and fall of the mercury for some days. Its greatest altitude in the air was 96° in the shade a few days prior to that date; but having lost these memoranda, I do not recollect the day, and it never fell, even during the night, lower than 85°. While we lay for some days at Balize, waiting for wind and tide to get over the bar, the average heat of the air at noon was 89°, and the thermometer in the water stood regularly at 88°, even when sunk to the depth of about four fathoms.

In making the experiments, the utmost care was taken that they should be accurately performed. The air and water thermometers had been attentively compared, and found exactly to agree when placed together; and a tin case, loaded with lead, was fitted to the instrument used for ascertaining the temperature of the water, for the double purpose of avoiding surface water, which might be supposed to be in some degree affected by the intensely hot solar rays, and of retaining water at the same heat round the tube, until such time as the instrument could be hauled on board, and the height of the mercury read off from the scale. The experiments were regularly repeated once in every watch, or four hours, but in particular situations they were made much oftener. The annexed table will shew that (at least at that particular season of the year), the nearness of *land*, or *soundings*, in the Gulf of Mexico, and in the strait between Cuba and the Tortugas, and Martyr's Reefs, had no effect on the thermometer; but that as soon as we passed Cape Florida, the very first opportunity we had of making a satisfactory experiment, viz. on the 11th September at 8 P. M. when conscious of our proximity to the shore to the southward of Cape Canaveral, it will be perceived how faithful a monitor it proved; and the same held good along the coast of America, as far as the 36th degree of latitude. Indeed, after the first two days subsequent to our quitting the strait, I had acquired such confidence in this valuable instrument, that when confined below by fever (being totally unable to keep the deck), I caused the thermometer to be regularly examined every two hours, and sometimes much oftener, and the result reported to me below; and the instant it fell two or three degrees, I caused the ship to be tacked, nor did it in a single instance betray me, as it invariably fell before we could find soundings with 100 fathoms. I call it a valuable instrument, and it truly proved so on that occasion to me; for with the wind dead on shore for about twelve or fourteen days, we had only, in a ship of 276 tons, four men and a boy fit for duty, all the rest being sick, officers included, with fever; indeed, some days it was with difficulty any of us could crawl on deck to take an observation; and, during that time, I almost consider that, for the safety of ship, cargo and crew, we were indebted to the thermometer.

It would occupy too much space, and require more time than I can at present devote to the purpose, to analyse the whole of the Thermometric Journal. Suffice it to say, that from lat. 38° 56′, and long. 62° 39′, the height of the mercury gradually decreased, until it seemed to rest between 74 and 76 degrees; but from about long. 44° to 33° W. running on the parallel of about 40°, or nearly so, it was extremely variable; and in lat. 39° 40′, long. about 34° 45′ it suddenly sunk to 72½°, which at the time led me to suspect the vicinity of some unknown shoal. Indeed I am disposed to think that the previous irregularity of the instrument was occasioned by the irregularity of depth of the Ocean; but though this idea suggested itself to me at the time, I did not consider myself entitled (with a fair and stiff breeze) to detain the ship on her voyage, by bringing to, in order to sound. It may, however, be here remarked, that all the Atlantic charts I have seen, depict various rocks and shoals of doubtful existence, almost in the track we came; and considering the proximity of the volcanic Azores, it is not unlikely that shoals may really exist, or have existed, but sunk again, like Sabrina Island at St Michael's.

Near the Islands of Fayal and Pico, and in the strait between the latter and St George's, the mercury fell to 70½°, but between these islands and St Michael's it again rose some degrees. In 17 fathoms water, (when the ship was at anchor) in the road of the city of *Ponta del Guda*, in St Michael's, it stood at 70°, and about two leagues in the offing it rose to 72° from thence it gradually subsided to 69°, at which it continued until the sea began to lose the deep azure of the ocean, and assume the dark olive-green tint, denoting soundings, when it immediately fell to 66°, though then no bottom could be found with 110 fathoms of line. And when abreast of Cape St Vincent, at about four miles distance from the pitch of the Cape, it only stood at 61°; but ascending, as we left the Portuguese coast, steering for the entrance of the Gut of Gibraltar, it again reached 69°. (*Vide* Table under date of October 17.)

In working through the Strait of Gibraltar, the mercury in the tube ranged from 60° to 66°, falling as we approached either the Spanish or the Barbary shores; but lowest on the latter, for which it is easy to account, as we stood much nearer it, the shoals and rocks to the westward of Tariffa Island rendering it imprudent to approach the Spanish coast too near; while the dangers in Tangier Bay, and off Cape Malabat, lie no great distance out from land: this induced me to prefer keeping clearest to the African coast.

On the coast of the United States of America, no vessel need run ashore without a previous warning of the proximity to land, if there is only a thermometer on board, and it is regularly attended to. However inaccurate the reckonings of the navigators on board may be, let us hope that, upon due examination, it will be found this instrument is not only invaluable on that side the Atlantic, but that it will be a faithful monitor of the approach to land or shoals throughout the ocean, or at any rate to the northward of the Tropic of Cancer, and probably to the southward of that of Capricorn.

Thermometrical Table extracted from a Journal kept on Board the Ship Asia, from New Orleans to Gibraltar, 1818.

Month.	Lat. N.	Long, W.	T.A.[*]	T. W.	Time of Observ.	REMARKS, &c.
Aug. 27.	. . . . .	. . . . .	90°	88°	Noon.	At anchor at Balize, river Missisippi.
28.	. . . . .	. . . . .	89	88	Ditto.	Ditto. ditto. ditto.
29.	. . . . .	. . . . .	88	88	Ditto.	Ditto. ditto. ditto.
—	. . . . .	. . . . .	89½	88	7 A. M.	Outside the Bar of the Missisippi.
30.	. . . . .	. . . . .	88½	90	1 P. M.	Greatest heat of water. Bar bore N. 62° W. distance 28 miles.
—	28°36′	88° 27′	87	87	8 A. M.	The days are reckoned according to sea account.

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[*] T. A. temperature of the air. T. W. temperature of the water.

Month.	Lat. N.	Long. W.	T. A.	T. W.	Time of Observ.	REMARKS, &c.
Aug. 30.	28° 29′	88° 21′	89°	87°	Noon.	Water apparently stationary.
31.	27 45	88 27	88	86	Ditto.	
July 1.	27 47	88 24	89	87	3 P. M.	
—	27 53	88 17	85	86	Midnight.	
—	27 28	88 12	89	87	Noon.	
2.	26 55	86 15	86	88	Ditto.	
3.	26 22	85 45	88½	86	Ditto.	
4.	25 51	85 22	89	86	Ditto.	
5.	25 17	85 06	87½	86	Ditto.	
6.	25 19	84 21	87	86	Ditto.	In these 24 hours a current set N. 4° W. 1.87 miles per hour.
7.	24 32	83 38	86	86	Ditto.	Waters set S. 71° W. 0.03 per hour, or nearly stationary.
8.	23 27	82 28	87	86	Ditto.	Entered into the Strait and Stream of Florida.
9.	24 11	80 41	86	86	Ditto.	
10.	25 48	79 30	83	85	Ditto.	
11.	. . . . .	. . . . .	84	85	6 P. M.	At 8 P. M. conceiving the ship to be on the edge of the bank of soundings, I examined the thermometer and found it sunk to 82°; tacked immediately off shore, and it soon rose again.
—	. . . . .	. . . . .	84	82	8 P. M.	
—	. . . . .	. . . . .	84	85	8½ P. M.	
—	27 30	79 35	85	85	Noon.	
12.	28 43	79 23	85	85½	Ditto.	Clear of the Strait of Florida.
13.	31 16	80 11	85½	82½	Ditto.	Mercury sunk as we neared the edge of soundings.
14.	31 31	80 03	87	83	Ditto.	
15.	32 52	78 15	85	82½	Ditto.	
16.	33 44	76 03	83½	84	Ditto.	
17.	35 32	73 04	84	82½	Ditto.	
18.	36 25	69 45	81	80	Ditto.	Little or no current this day.
20.	. . . . .	. . . . .	80	80	Ditto.	No observations, the sky being obscured by clouds.
21.	38 56	62 39	82	77	Ditto.	Thermometer suddenly rose to 80°, and continued so for about 10 hours; and at noon we found by observation that during the preceding 48 hours we had been set 1° 2′ N. by a current.
Oct. 17.	35 58 30″	7 00 00″	66	69	Noon.	
18.	35 51 00	6 34 00	66	68	Ditto.	
19.	36 03 34	6 20 15	68	65½	Ditto.	Tower on Cape Trafalgar bearing *true* N. 67° 30′ E. six leagues.
20. 21. 22.	36 09 10	. . . . .	. . .	64	. . . . .	At anchor in Gibraltar Bay in five fathoms.

ART. VII.—*Notice respecting the Archipelago of John Potocki.* By M. JULIUS VON KLAPROTH, Aulic Councillor to the Emperor of Russia *.

THE Yellow Sea was first visited by European navigators in the year 1793, when the Lion conducted Lord Macartney to China, but it did not approach the coasts of Corea, near the Tartaro-Chinese province of Liao-toung.

In 1816, when the Alceste, under Captain Maxwell, and the Lyra, under Captain Basil Hall, conducted the late embassy to China, this part of the world was explored with great accuracy, and innumerable islands were discovered on the western coast of Corea. These vessels, however, kept at a considerable distance from the south coast of Liao-toung, which terminates the Yellow Sea on the north, and hence this coast is entirely unknown to European navigators.

In the year 1707, the Emperor of China, Kang-hee, employed the two missionaries, Father Gerbillas and Pereira, to make a survey of his extensive dominions,—a task which they accomplished in the year 1715, and which contributed greatly to extend our knowledge of those vast countries which form the eastern part of Upper Asia. These maps were engraved at Pekin, and several editions of them were published, both in the Chinese and the Mandchouc languages. Copies of these maps, with the Chinese and Tartar names transcribed in French, were immediately transmitted to Europe by the missionaries, and from these materials D'Anville composed the maps which accompany Duhalde's description of China, and which subsequently appeared in a separate form, under the title of *Atlas de la Chine.* Unfortunately, however, D'Anville knew neither the Chinese nor the Mandchouc languages, and hence the maps which he constructed were filled with innumerable errors, which still exist in the most recent maps of that country.

" The original plates, says M. Klaproth, came by accident into my possession, and I presented them to the Russian Government in the year 1818. The map of each of the fifteen provinces of China, forms, as in the atlas of D'Anville, a separate sheet, whereas Tartary is divided into twelve sheets, which form a single chart. In examining these last, I remarked that they went no farther south than the 40th degree of north latitude, so that they wanted the southern point of the Chinese province of Liao-toung exactly as in the first sheet of the Tartary of D'Anville (See Duhalde, tom. iv. p. 64). This illustrious geographer, however, had filled up the blank, but probably from conjecture. In order to obtain information on this point, I consulted the original Chinese and Mandchouc of the charts in my possession, and I found not only the point of Liao-toung * represented otherwise than in the charts of D'Anville; but they shewed me *that to the south of the southern coast of this province there is a group of* EIGHTEEN *islands, which are not indicated in any of our charts,* and which were not discovered in 1816 by Captain Maxwell and Captain Hall, who were a degree too far south to perceive this new Archipelago."

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* Abridged and translated from the *Annales des Voyages*, *&c.*, par MM. Eyrie and Malte-Brun, tom iv. p. 383.

"I may therefore say, without too much vanity, that I am the first European who discovered these Islands, shut up in my cabinet, and without exposing myself to the fury of the storms which so frequently rage in the Chinese seas. As these islands have no general name in the Chinese charts, I have given them that of the late *Count John Potocki,* whom I had the honour of accompanying on the voyage of the Russian embassy destined for China.

"The Archipelago of John Potocki is situated between the 39th and the 40th degree of north latitude, and the 124th and 125th degree of longitude east from Greenwich. It belongs to the Tartaro-Chinese province of Liao-toung and to the district of Fung-thian-fou, better known in Europe under the name of Moukden. It is dependent on the city of Ning-hai-hian situated to the north of the promontory called the *Regent's Sword.*

"The great system of Chinese geography, published in 1744, under the title of Thai-thsing-y-thoung-tchy, gives only a succinct and uninteresting description of them, confining itself nearly to the statement of the number of *ly*, (250 of which made a degree,) that each island is distant from Ning-hai-hian. I have translated this nomenclature, and added an asterisk to the names of those islands, which are not marked upon the Jesuit's charts.

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* The promontory which terminates in this point, was called by Captain Maxwell the *Regent's Sword,* from its resemblance to a sabre. See Macleod's *Voyage of the Alceste,* p. 34.—ED.

* *Lian-houa-tao* is thirty ly to the east of the city of Ning-hai-hian. The geography of the dynasty of Ming, (published in 1461,) says, that the city of *Kintcheou*, (actually Ning-hai-hian,) had under its jurisdiction seventy-two islands, surrounded by the waves of the sea. At 150 ly to the north-east, there is an island called Siao-kia-tao, and on which there was a guard.

* *Kin-sian-tao,* or the Island of the Sons of Gold, is 10 ly to the east of Ning-hai-hian. The Islands of *Khou-leou-tao,* the Isle of the Crane, and *Ma-ngan-tao,* the Island of the Saddle, are 110 ly to the east of the same town.

Kouang-lou-tao, or the Island of Radiating Happiness, is 120 ly to the east of Ning-hai-hian.

Koua-phi-tao, or the Isle of the Shaver. This is 130 ly to the east of the same town, although in the charts it is situated farther west than the preceding island.

Hui-sian-tao, or the Island of the Immortal of the Sea, is 150 ly to the east of Ning-hai-hian.

Ta-tchhang-chan-tao, or the Great Isle of the Long Mountain, is 150 ly to the east of the same town. *Siao-tchkang-chan-tao,* or the Small Isle of the Long Mountain, is 10 ly to the south-east of the Great Isle.

Che-li-tao, or the Isle of the Bones of Foe or Bouddha, is 160 ly to the east of Ning-hai-hian.

Pa-tchha-tao, or the Isle of the Eight Forks or Harpoons, is 170 ly to the east of the same town.

Chy-tchhing-tao, or the Island of the City of Stone, is 180 ly to the east of the same place. *Ouang-kia-tao,* or the Island of the Royal House, and *Ou-mang-tao,* are 190 ly to the east; *Tchang-tsu-tao,* or the Isle of Deer; and *Hai-yang-tao,* are 200 ly to the east; and *Tha-lian-tao,* the Island of the Contiguous Towers, 210 ly to the east of Ning-hai-hian.

Ta-hao-tsutao, is 215 ly to the east of Ning-hai-hian.

Siao-hao-tsu-tao, 225 ly to the east of the same place.

Siao-hai-thsing-tao, or the Small Isle of the Falcons, is 20 ly to the south-east; and

Ta-hai-thsing-tao, 50 ly to the south-east of Ning-hai-hian.

The great Chinese Geography contains nothing more on these islands, and does not even mention the most southern, which is named in the chart *Kouang-theou-tao*, or the Isle of the Shining Head. According to other Chinese works, they are the entrepot of the maritime commerce between China and Corea, and the navigators who go from one of these countries to the other, frequently put into their harbours.

ART. VIII.—*On Isothermal Lines, and the Distribution of Heat over the Globe.* By Baron ALEXANDER DE HUMBOLDT. (Continued from Vol. III. p. 20.)

HAVING discussed the method of taking averages, and of reducing temperatures to general expressions, we shall now proceed to trace the course of the *Isothermal Lines* on the surface of the Globe, and at the level of the sea. From a slight attention to the difference of climates, it has been remarked, more than a century ago, that the temperatures are not the same under the same parallels; and that in advancing 70° to the east or the west, the heat of the atmosphere suffers a sensible diminution. In pursuance of our method, we shall reduce these phenomena to numerical results, and shew that places situated under the same latitudes do not differ, in America and Europe, by the same number of degrees of temperature, as has been vaguely stated. This assertion would make us suppose that the isothermal lines are parallel in the temperate zone.

		Lat.	Mean Temp.
I. Parallels of Georgia, of the State of Mississippi, of Lower Egypt, and Madeira.	*Natchez*, -	31° 28′	64° 8′
	Funchal, -	32 37	68 7
	Orotava, -	28 25	69 8
	Rome, -	41 53	60 4
	Algiers, -	36 48	70 0
	Difference,	7 0	4 1

		Lat.	Mean Temp.
II. Parallels of Virginia, Kentucky, Spain, and the South of Greece.	*Williamsburg,*	38° 8′	58° 0′
	Bourdeaux,	44 50	56 5
	Montpellier,	43 36	59 4
	Rome,	41 53	60 4
	Algiers,	36 48	70 0
	Difference,	7 0	7 7
III. Parallels of Pennsylvania, Jersey, Connecticut, Latium, and Romelia.	*Philadelphia,*	39 56	54 9
	New-York,	40 40	53 8
	St Malo,	48 39	54 5
	Nantes,	47 13	54 7
	Naples,	40 50	63 3
	Difference,	7 0	9 5
	Ipswich,	42 38	50 0
	Cambridge (Amer.)	42 25	50 4
	Vienna,	48 13	50 5
	Manheim,	49 29	51 3
	Toulon,	43 7	62 1
	Rome,	41 53	60 4
	Difference,	6 30	11 0
IV. Parallels of Canada, Nova Scotia, France, and the South of Germany.	*Quebee,*	46 47	41 9
	Upsal,	59 51	41 9
	Padua,	45 24	57 7
	Paris,	48 50	51 4
	Difference,	13 0	12 6
V. Parallels of Labrador, the South of Sweden, and Courland.	*Nains,*	57 0	26 4
	Okak,	57 20	29 8
	Umea,	63 50	33 3
	Enontekies,	68 30	27 0
	Edinburgh,	55 58	47 8
	Stockholm,	59 20	42 3
	* Difference,	11 0	17 1

This table † indicates the difference of climates, expressed by that of the mean temperature, and by the number of degrees in latitude which it is necessary to go northward in Europe, in order to find the same quantity of annual heat as in America As a place could not be found in the Old World, whose mean temperature was 48° the same as that of Williamsburg, I have supplied it with an interpolation between the latitudes of two points whose mean temperatures are 56°.5 and 59°.4. By an analogous method, and by employing only good observations, I have found that

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* The differences under the column of latitudes, is the difference of the latitude of a place in Europe and a place in America, which have the same mean temperature; and the differences under the column of mean temperatures, is the difference of the mean temperatures of a place in Europe and a place in America, which have the same latitude.—Ed.

† See my *Prolegomena de distributione geographica plantarum, secundum cæli temperiem et altitudinem montium.* p. 68.—H.

1. The *isothermal line* of 32° (0° centig.) passes between Uleo and Enontekies in Lapland (lat. 66° to 68°; East long. from London 19° to 22°), and Table Bay in Labrador (lat. 54° 0', west long. 58°.)

2. The *isothermal line* of 41° (5° centig.) passes by near Stockholm (lat. 60° east long. 18°) and the Bay of St George in Newfoundland (lat. 48°, and long. 59°.)

3. The *isothermal line* of 50° (10° centig.) passes by Belgium (lat. 51°, east long. 2°) and near Boston (lat. 42° 30′, west long. 70° 59.)

4. The *isothermal line* of 59° (15° centig.) passes between Rome and Florence (lat. 43° 0′, east long. 11° 40′) and near Raleigh in North Carolina (lat. 36° 0′, and west long. 76° 30′.)

The direction of these lines of equal heat, gives for the two systems of temperature, which we know by precise observations, viz. part of the middle and west of Europe, and that of the coast of America, the following differences:

Latitude.	Mean Temp. of the west of the Old World.	Mean Temp. of the east of the New World.	Difference.
30	70°.52	66°.92	3°.60
40	63.14	54.50	8.64
50	50.90	37.94	12.96
60	40.64	23.72	16.92

If we call the mean equatorial temperature 1, we shall have the half of this temperature in the Old World at 45°, and in the east of the New World, at 39° of lat *.

The mean temperatures decrease

Latitude.		Temp.		Temp.
From 0° — 20°	In the Old World,	3°.6	In the New World,	3°.6
20 — 30		7.2		10.8
30 — 40		7.2		12.6
40 — 50		12.6		16.2
50 — 60		9.9		13.3
0 — 60		40.5		56.5

In both contine[illegible] zone in which the mean temperature decreases most r[illegible]ehended between the parallels of

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* This observatio[illegible]grade scale. If we count the temperatures from 32°, it app[illegible]t's scale.—Ed.

40° and 45°. Observation here presents a result entirely conformable to theory, for the variation of the square of the cosine, which expresses the law of the temperature, is a *maximum* towards 45° of latitude. This circumstance ought to have a favourable influence on the civilization and industry of the people who inhabit the regions under this mean parallel. It is the point where the regions of the vines touch those of the olives and the citrons. On no other part of the globe, in advancing from north to south, do we observe the temperatures increase more sensibly, and no where else do vegetable productions, and the various objects of agriculture, succeed one another with more rapidity. But a great difference in the productions of contiguous countries, gives activity to commerce, and augments the industry of the cultivators of the soil.

We have traced the direction of the isothermal lines from Europe to the Atlantic Provinces of the New World. We have seen them approach one another from parallelism towards the south, and converge towards the north, particularly between the thermometric curves of 41° and 50°: We shall now endeavour to pursue them to the west. North America presents two chains of mountains, extending from N. E. to S. W., and from N. W. to S. E. forming almost equal angles with the meridian, and nearly parallel to the coasts which are opposite to Europe and Asia, viz. the chain of the *Alleghanys* and the *Rocky Mountains*, which divide the waters of the Missouri and the Columbia. Between these chains stretch the vast basin of the Mississippi, the plains of Lousiana, and of the Tenessee, and the states of Ohio, the centre of a new civilization. It is generally believed in America that the climate is more mild to the west of the Alleghany Mountains, than under the same parallels in the Atlantic States *. Mr Jefferson, has estimated the difference at 3° of latitude; and the *Gleditsia monosperma*, the *Catalpa*, and the *Aristolochia Sypho*, and other vegetable productions, are found so many degrees farther to the north, in the basin of the Ohio, than on the coast of the Atlantic †.

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* This is true also of the Columbian Valley. See Warden's *Account of the United States*, vol. iii. p. 169.—Ed.

† See my *Essai sur la Geographie des Plantes*, p. 154.

M. Volney has endevoured to explain these phenomena by the frequency of the south-west winds, which drive back the warm air of the Gulf of Mexico towards these regions. A series of good observations, made for *seven* years by Colonel Mansfield at Cincinnati, on the banks of the Ohio, and recently published by Mr Drake, in an excellent treatise on American meteorology[*], has removed the doubts which obscured this point. The thermometrical *means* prove that the isothermal lines do not rise again in the regions of the west. The quantity of heat which each point of the globe receives under the same parallels, is nearly equal on the east and the west of the Alleghany range, the winters being only a little milder to the west, and the summers a little warmer[†]. The migrations of vegetables towards the north are favoured in the basin of the Mississippi, by the form and the direction of the valley which opens from the north to the south. In the Atlantic Provinces, on the contrary, the valleys are transverse, and oppose great obstacles to the passage of plants from one valley to another.

If the isothermal lines remain parallel, or nearly so, to the equator, from the Atlantic shores of the New World to the east of the Mississippi and the Missouri, it cannot be doubted that they rise again beyond the *Rocky Mountains*, on the opposite coast of Asia, between 35° and 55° of latitude. To the consi-

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[*] *Natural and Statistical View or Picture of Cincinnati and the Miami Country*, 1 vol. 8vo. Cincinnati.—H. See Warden's *Account of the United States*, vol. ii. 236. for an abstract of Mr Drake's results.—Ed.

[†] The following comparison of the mean temperatures has been deduced with great care.

CINCINNATI.	Lat. 36° 6′, west long. 84° 24′.	PHILADELPHIA.	Lat. 39° 56′, west long. 75° 16′.
Winter,	32°.9 Fahr.	Winter,	32°.2 Fahr.
Spring,	54.1	Spring,	51.4
Summer,	72.9	Summer,	73.9
Autumn,	54.9	Autumn,	56.5
Mean,	53.7	Mean,	53.5

I have taken for Philadelphia the means between the observations of Coxe and Rush. I have also refe[illegible]tion to the observations made by M. Legaux at Spring-Mill upon the [illegible] north of Philadelphia. As Cincinnati is 512 feet above the le[illegible] temperature is 1°.4 too low.— H.

derations which I pointed out in my work on Mexico[*], are to be added the observations of Captain Lewis, and some other Anglo-American travellers, who have passed the winter on the banks of the Columbia. In New California, they cultivate with success the olive, along the canal of Santa Barbara, and the vine from Montercy to the north of the parallel of 37°, which is that of Chesapeake Bay. At Nootka, in the Island of Quadra and Vancouver, and almost in the latitude of Labrador, the smallest rivers do not freeze before the month of January. Captain Lewis saw the first frosts near the embouchure of the Colombia, only on the 7th of January, and the rest of the winter was rainy. Through 122° 40′ of west long. the isothermal line of 50° Fahr. appears to pass almost as in the Atlantic part of the Old World, at 50° of lat. The western coasts of the two worlds resemble one another to a certain point[†]. But these returns of the isothermal lines do not extend beyond 60°. The curve of 32° Fahr. is already found to the south of the Slave Lake, and it comes still farther south in approaching Lakes Superior and Ontario.

In advancing from Europe towards the east, the isothermal lines again descend[‡], the number of fixed points being few. We can only employ those which are made in places whose known elevation allows us to reduce the mean temperatures to the level of the sea. The few good materials which we possess, have enabled us to trace the curves of 32° and 55°.4. We know even the nodes of the latter curve round the whole globe. It

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[*] *Essai Politique sur la Nouvelle Espagne*, tom. ii. p. 440, 478, 509.

[†] On account of the influence of west and south-west winds. See Dalton's *Meteor. Observ.* p. 125.

[‡] In comparing places from the west to the east, and nearly under the same parallel, we find,

West.	Lat.	Mean Temp.	East.	Lat.	Mean Temp.
St Malo,	48° 39′	54°.5	Vienna,	48° 13′	50°.5
Amsterdam,	52 21	53 .4	Warsaw,	52 14	48 .6
Naples,	40 50	63 .3	Pekin,	39 54	54 .9
Copenhagen,	55 41	45 .7	Moscow,	55 46	40 .1
Upsal,	59 52	41 .9	Petersburgh,	59 56	38 .8

The elevation of Pekin is inconsiderable. That of Moscow is 984 feet. The absolute temperature of Madrid, to the west of Naples, is 59°; but the city is elevated 1978 feet above the level of the sea.—H.

passes to the N. of Bourdeaux, (lat. 45° 46′, W. long. 0° 37′,) near Pekin, (lat. 39° 54′, E. long. 116° 27′.,) and Cape Foulweather to the S. of the embouchure of the Colombia, (lat. 44° 40′, W. long. 104°.) Its nodes are distant at least 162° of longitude. We have here pointed out only the empirical laws, under which are ranged the general phenomena, and the variations of the temperature which embrace at once a vast extent of the globe. There are *partial inflexions* of the isothermal lines, which form, so to speak, particular systems modified by small local causes; such as the strange inflexion of the thermometric curves on the shores of the Mediterranean, between Marseilles, Genoa, Lucca and Rome [*], and those which determine the difference between the climate of the western coast and the interior of France. These last depend much less on the quantity of heat received by a part of the globe during the whole year, than upon the unequal distribution of heat between winter and summer. It will one day be useful to have upon particular charts the partial inflections of the isothermal lines, which are analogous to the lines of soundings or of equal declivity. The employment of graphical representations will throw much light upon phenomena, which are deeply interesting to agriculturists. If, in place of geographical charts, we possessed only tables containing the co-ordinates of latitude, longitude, and altitude, a great number of curious facts relative to the configuration and the superficial inequalities of continents would have remained forever unknown.

We have already found, that towards the north, the isothermal lines are neither parallel to the equator nor to one another; and it is on account of the want of parallelism, that we have, in order to simplify such complicated phenomena, traced round the whole globe the curves of equal heat. The position of the line of 32° acts like the magnetic equator, whose inflexions in the South Sea modify the inclinations at great distances. We may even believe that, in the distribution of climates, the line of 32° determines the position of the *curve of greatest heat*,

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	La	[illegible]		Lat.	Mean Temp.
[*] Bologna,	44°	[illegible]	Marseilles,	43° 17′	58°.8
Genoa,	44	[illegible]	Rome,	41 53	60.4

H,

which is as it were the isothermal equator, and that in America and Asia through 78° of west, and 102° of east longitude, the torrid zone commences more to the south of the tropic of Cancer, or that it there presents temperatures of less intensity. An attentive examination of the phenomena proves that this is not the case. Whenever we approach the torrid zone below the parallel of 30°, the isothermal lines become more and more parallel to one another, and to the earth's equator. The great colds of Canada and Siberia do not extend their action to the equatorial plains. If we have long regarded the Old World as warmer between the tropics than the new world, it is, *first*, Because till 1760, travellers used thermometers of spirit of wine, coloured, and affected by light; *2d*, Because they observed it either under the reflection of a wall, or too near the ground, and when the atmosphere was filled with sand; and, *3d*, Because in place of calculating the true *mean*, they used only the thermometric *maximum* and *minimum*. Good observations give,

OLD WORLD.	Lat.	Mean Temp.	NEW WORLD.	Lat.	Mean Temp.
Senegambia,	15° 0	79°.07	Cumana,	10° 27′	81°.86
Madras,	13 5	80 .42	Antilles,	17 0	81.05
Batavia,	6 12	80 .42	Vera Cruz,	19 11	78.08
Manilla,	14 36	78 .08	Havannah,	23 10	78.08

The mean temperature of the equator cannot be fixed beyond 81½°. Kirwan values it at 84°, but only two places of the earth were known, viz. Chandernagor and Pondicherry, to which old travellers attributed annual temperatures above 81°½. At Chandernagor, in latitude 21°.6, the mean temperature, according to Cotte, is 91°.9, but the Jesuite Boudier marked only the days when the thermometer was above 98°.6, and below 57°.2. And at Pondicherry, in latitude 11° 55′, the mean temperature, according to Cotte, is 85°.3, and according to Kirwan, 88°; but M. de Cossigny observed with a spirit-of-wine thermometer.

The distribution of heat over different parts of the year differs, not only according to the decrease of the mean annual temperatures, but also in the same isothermal line. It is this unequal division of the heat which characterises the two systems of climate of Europe and Atlantic America. Under the torrid zone, a small number of months are warmer in the Old World than in the New. At Madras, for example, according to Dr

Roxburgh, the mean temperature of June is 89°.4; at Abusheer 93°.2, but at Cumana I have found it only 84°.6.

With respect to the temperate zone, it has been long known, that from the parallel of the Canary Isles to the Polar Circle, the severity of the winter augments in a progression much more rapid than the summers diminish in heat. It is also known, that the climate of the islands and the coasts differs from that of the interior of continents, the former being characterised by mild winters and less temperate summers. But it is the heat of summer particularly which affects the formation of the amylaceous and saccharine matter in fruits, and the choice of the plants that ought to be cultivated. As the principal object of this memoir is to fix, after good observations, the numerical relations between the unequal quantities of heat distributed over the globe, we shall now compare the mean temperatures of three months of winter and summer under different latitudes, and shew how the inflections of the isothermal lines modify these relations. In following the curves of equal heat from west to east, from the Basin of the Mississippi to the eastern coasts of Asia, through an extent of 4000 leagues, we are struck with the great regularity which appears in the variations of the winter temperature.

I. *Differences of the Seasons from the Equator to the Polar Circle.*

	Cisatlantic Region. Long. 1° W. and 17° E.			Transatlantic Region. Long. 58°— 72° W.		
	Mean Temperature.			Mean Temperature.		
Isothermal Lines of	Winter,	Summer.	Diff.	Winter.	Summer.	Diff.
68°	59°.0	80°.6	21°.6	53°.6	80°.6	27°.0
59	44.6	73.4	28.8	39.2	78.8	39.6
50	35.6	68.0	32.4	30.2	71.6	41.4
41	24.8	60.8	36.0	14.0	66.2	52.2
32	14.0	53.6	39.6	1.4	55.4	54.0

This table shews the increase of the difference between the winters and summers from 28° and 30° to the parallels of 55° and 65°. The [illegible] more rapid in the Transatlantic Zone, where the [illegible] of 32° and 50° approach one another very mu [illegible] arkable, that in the two zones which form the t [illegible] erent climates, the division of the annual temperature between winter and summer is made in such a manner, that, upon the isothermal line of 32°, the difference of the two seasons is almost double of that which is observed on the isothermal line of 68°.

Cisatlantic Region.
Long. 31° E. and 22° W.

Places.	Latitude.	Mean Temperature.		
		Whole Year.	Winter.	Summer.
(Pondicherry)	11°.55	85°.3	77°.0	90°.5
Cairo,	30 02	72.7	57.7	84.7
Funchal,	32 37	68.7	63.9	72.5
Rome.	41 53	60.4	45.9	55.2
Bourdeaux,	44 50	56.5	42.1	70.7
Paris,	48 50	51.4	38.3	66.2
Copenhagen,	55 41	45.7	30.7	64.6
Stockholm,	59 20	42.3	25.5	61.9
Drontheim,	63 24	39.9	24.7	61.3
Umeo,	63 50	33.3	12.9	54.9

Transatlantic Region.
Long. 69° E. and 99° W

Places.	Latitude.	Mean Temperature.		
		Whole Year.	Winter.	Summer.
Cumana,	10°.27	81°.9	81°.7	83°.7
Havannah,	23.10	78.1	71.2	83.3
Natchez,	31.28	64.8	48.6	79.2
Cincinnati,	39.06	53.6	32.9	72.9
Philadelphia,	39 56	54.9	32.2	73.9
New York,	40.40	53.8	29.8	79.2
Cambridge,	42.25	50.4	34.0	70.5
Quebec,	46.47	41.9	14.2	68.0
Nain,	57.10	26.4	0.6	48.4
Fort Churchhill,	59.02	25.3	6.8	52.2

If, instead of the mean temperatures of the seasons, we consider, I do not say the days of the *maxima* and *minima* of the year, which are the ordinates of the concave and convex summits of the entire curve, but the mean temperatures of the warmest and the coldest month, the increase of the differences becomes still more perceptible. We request the reader to compare in the following Table only the places which belong to regions bounded by the same meridians, and consequently to the same system of climate; as for example, to the region of Eastern America to that of Western Europe, and that of Eastern Asia. We must also attend to the changes of temperature produced by the monsoons in a part of the equinoctial regions, and distinguish under the temperate zone between the climate of the interior, or the continental climate, and that of islands and coasts.

Places.	Lat.	Mean Temperature.		Difference.	**Observations.**
		Coldest Month.	Warmest Month.		
Cumana,	10° 27	80°.1	84°.4	4°.3	Uninterrupted trade winds.
Pondicherry,	11 55	76.1	91.4	15.3	Monsoons. Radiation of the sands.
Manilla,	14 36	68.0	86.9	18.9	Monsoons.
Vera Cruz,	19 11	70.0	81.7	11.7	North winds in winter.
Cape Français,	19 46	77.0	86.0	9.0	Uninterrupted trade winds.
Havannah,	23 10	70.0	83.8	13.8	North winds in winter.
Funchal,	32 37	64.0	75.6	11.6	Insular climate.
Natchez,	31 28	46.9	78.8	31.9	Transatlantic region. Interior.
Cincinnati,	39 6	29.6	74.4	44.8	Same system of climate.
Pekin,	39 54	24.8	84.2	59.4	Region of eastern Asia.
Philadelphia,	39 56	29.8	77.0	47.2	Transatlant. region. Eastern coasts
New York,	40 40	25.3	80.8	55.5	*Idem.*
Rome,	41 53	42.1	77.0	34.9	Cisatlantic region.
Milan,	45 28	33.8	55.2	21.4	Interior land.
Buda,	47 29	27.7	71.6	43.9	*Idem.*
Paris,	48 50	35.1	69.8	34.7	Nearer the western coast.
Quebec,	46 47	14.0	73.4	59.4	Transatlant. region. Eastern coasts
Dublin,	53 21	37.6	60,3	22.7	Region of the west of Europe. Insular climate.
Edinburgh,	55 58	38.3	59.4	21.1	*Idem.*
Warsaw,	52 14	27.1	70.3	43.2	Interior land.
Petersburg,	59 56	8.6	65.7	57.1	East of Europe.
North Cape,	71 0	22.1	46.6	24.5	Climate of coasts and islands.

We may conclude in general, that for any given place in the curves which express the annual temperatures, the ordinates of the concave and convex summits differ the more from one another, as the temperatures diminish. In the New World, under 40° of latitude, we find a greater difference between the warmest and coldest months of the year than in the Old World, at Copenhagen and Stockholm under 56°—59° of latitude. At Philadelphia the thermometer descends to 50° or 59° below the freezing point, while under the same parallel in Europe it descends scarcely 30°.6 below it.

I have endeavoured to shew, in another work, how this circumstance which characterises the regions which Buffon indicates by the name of *Excessive Climates*, influences the physical constitution of the inhabitants. In the United States, the Europeans, an [redacted] all the natives, are, with great difficulty, inured to the winters that have been very rigorous, not from perature, but from an extreme depression of the e irritability of the nervous system is prodigiously increased by the excessive heat of summer; and it is undoubtedly to this cause that we must, in a great measure, ascribe the difference in the propagation of the yellow fever, and the different forms of the marsh fever, under the equator, and in the temperate zone of the New World *. On high mountains in islands of little extent, and along the shores, the lines of annual temperature take nearly the same form as in warm climates, having only a less degree of curvature. The difference between the seasons, too, becomes smaller. At the North Cape, in 71° of latitude, and in the isothermal line of 32°, it is almost 11° greater than at Paris, in 49° of latitude, and in the isothermal line of 50°. The sea-breezes and the fogs which render the winters so temperate, diminish at the same time the heats of summer †. The characteristic of any climate is not the difference between the winters, expressed in degrees of the thermometer;—it is this difference, compared with the absolute quantities indicated by the mean temperature of the seasons.

II. *Difference between the Winters and Summers, in following the same Isothermal Line from West to East.*

The differences between the seasons of the year are less great near the convex summits of the isothermal curves, where these curves rise again towards the North Pole, than near the concave summits. The same causes, which affect the inflexion or the greatest curvature of the isothermal lines, tend also to equalise the temperatures of the seasons.

The whole of Europe, compared with the eastern parts of America and Asia, has an insular climate, and, upon the same isothermal line, the summers become warmer, and the winters colder, in proportion as we advance from the meridian of Mont Blanc towards the east or the west. Europe may be considered as the western prolongation of the old continent; and the western parts of all continents are not only warmer at equal latitudes than the eastern parts, but even in the zones of equal annual temperature, the winters are more rigorous, and the summers hotter on the eastern coasts than upon the western coasts of the two continents. The northern part of China, like the Atlantic region of the United States, exhibits *excessive climates*, and seasons strongly contrasted, while the coasts of New California, and the embouchure of the Colombia, have winters and summers almost equally temperate. The meteorological constitution of these countries in the N. W. resembles that of Europe as far as 50° or 52° of latitude; and without wishing to ascribe the great revolutions of our species solely to the influence of climate, we may affirm that the difference between the eastern and western shores of continents, has favoured the ancient civilisation of the Americans of the west,—facilitated their migrations towards the south, and multiplied those relations with eastern Asia, which appear in their monuments, their religion, traditions, and the division of the year. In comparing the two systems of climates, the concave and convex summits of the same isothermal lines, we find at *New York* the summer of *Rome* and the winter of *Copenhagen*;—at *Quebec* the summer of *Paris* and the winter of *Petersburg*. In China, at *Pekin* for example, where the mean temperature of the year is that of the coasts of Britanny, the scorching heats of summer are greater than at Cairo, and the winters as rigorous as at Upsal.

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* *Political Essay on the Kingdom of New Spain*, tom. iv. p. 528.

† Leopold von Buch's *Travels in Lapland*, tom. ii.

The mean temperature of the year being equal to the fourth part of the winter, spring, summer and autumnal temperatures, we shall have upon the same isothermal line of 53° 6′ (12° cent.)

At the *concave* summit in *America*, 74° 40′ west long. $53^\circ.6 = \frac{32^\circ + 52^\circ.3 + 75^\circ.6 + 54^\circ.5}{4}$

At the *convex* summit in *Europe*, 2° 20′ west long. $53^\circ.6 = \frac{40^\circ.1 + 51^\circ.8 + 68^\circ.4 + 54^\circ.1}{4}$

At the concave summit in Asia, 116° 20′ east long. $53^\circ.6 = \frac{-24^\circ.8 + 54^\circ.7 + 80^\circ.6 + 54.3}{4}$

This analogy between the eastern coasts of Asia and America, sufficiently proves that the inequalities of the seasons, of which we have endeavoured to fix the numerical relations, depend on the prolongation and enlargement of continents towards the pole; of the size of seas in relation to their coasts, and on the frequency of the N. W. winds, which are the *Vents de Remous* of the temperate zone, and not on the proximity of some plateau or elevation of [illegible]jacent lands. The great plateaus of Asia do not stretch [illegible] latitude; and in the interior of the New Contine[illegible]se basin bounded by the Alleghany Range, an[illegible]untains, and covered with secondary formatio[illegible]than from 656 to 920 feet above

When we consider that the annual temperature of a place is nothing more than the numerical expression of the mean of the ordinates, we may imagine an infinity of entirely dissimilar curves, in which the twelve ordinates of the months have exactly the same mean. This consideration should not lead us to believe, that a place which has the winter of the south of France, that is, where the mean temperature of winter is 44°.6, may, by the compensation of a summer and an autumn, much less warm, have the mean temperature of Paris. It is true, that the constant ratio which is observed in the same parallel, between the solstitial heights of the sun and the semidiurnal arcs, is differently modified by the position of a place in the centre of a continent or upon the coast, by the frequency of certain winds, and by the constitution of an atmosphere more or less favourable to the transmission of light, and of the radiating caloric of the earth. But these variations, which travellers have often exaggerated, have a maximum which nature never oversteps. It is impossible to examine the preceding table without observing, that the division of the annual heat between summer and winter, follows on each isothermal line a determinate type; that the deviations of that type are contained between certain limits, and that they obey the same law in the zones which pass by the concave or convex summits of the isothermal lines, for example, by 58°—68° of West Long., and by 5°—7°, and 116° of East Longitude.

The following table shews the oscillations, or the *maxima* and *minima*, observed in the division of the heat between the seasons. I have added the means of the winters and summers found at different degrees of longitude, and under the same isothermal line.

Isoth. Lines.	Degrees of Long. examined.	Oscillations observed in the Means.				Means calculated.	
		Winters.		Summers.		Winters.	Summers.
32°	83	3°.2 to	24°.8	51°.8 to	53°.6	14°.0	52°.7
41	[illegible]	[illegible]	24.8	62.6	68.0	19.4	65.3
50	[illegible]	[illegible]	[illegible]	62.6	78.8	30.2	70.7
59	[illegible]	[illegible]	[illegible]	75.2	77.0	41.9	75.2
68	[illegible]	[illegible]	[illegible]	71.6	80.6	56.3	77.9

The deviations round the mean, that is, the inequality of the winters on the same isothermal line, increase in proportion as the annual heat diminishes, from Algiers to Holland, and from Florida to Pennsylvania. The winters of the curve of 68° are not found upon that of 51°, and the winters of 51° are not met with on the curve of 42°. In considering separately what may be called the same *system of climate*, for example, the European Region, the Transatlantic Region, or that of Eastern Asia, the limits of the variations become still more narrow. Wherever in Europe, in 40° of longitude the mean temperature rises

To 59°.0	The winters are from	44°.6 to	46°.4	and the summers from	73°.0 to	75°.2
54.5		36.5	41.0		68.0	73.0
50.0		31.1	37.4		62.6	69.8
45.5		28.4	36.1		57.2	68.0
41.0		20.3	26.8		55 4	66.2

In tracing *five* isothermal lines between the parallels of Rome and Petersburg, the coldest winter presented by one of these lines is not found again on the preceding line. In this part of the globe, those places whose annual temperature is 54° 5, have not a winter below 32°, which is already felt upon the isothermal line of 50°. If, in place of stopping at the most rigorous winter which each curve presents, we trace the *lines of equal winter temperature*, (or the *Isocheimal lines*,) these lines, instead of coinciding with the lines of equal annual heat, oscillate round them. As the *Isocheimal lines* unite points placed on different isothermal lines, we may examine to what distance their summits extend. In considering always the same system of climates, for example, the European region, we shall find that the lines of equal winter cut isothermal lines, which are 9° distant. In Belgium * (in latitude 52°, and in isothermal latitude 51° 8,) and even in Scotland, (in latitude 57°, and isothermal latitude 45° 5,) the winters are more mild than at Milan, (in latitude

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* Throughout all Holland, 90 days of winter have a mean temperature of from 36°.7 to 38°.7. At Milan, at Padua, and at Verona, the same season is only from 34°·7 to 36°.7. The observations made in Belgium and Holland, offer also a very remarkable example of an equal quantity of heat distributed in the space of a year over a vast extent of territory. The mean temperatures scarcely vary from Paris to Franecker, over 3½ degrees of latitude, which, in the interior of a continent, should produce a difference of 3¼ degrees of annual temperature. The canal of the Channel opens towards the north. The west winds blow, therefore, over a great

45° 28′, and isothermal latitude 55° 8′,) and in a great part of Lombardy. Farther to the north, in the Scandinavian Peninsula, we meet with three very different systems of climate, viz. 1. The region of the west coasts of Norway to the west of the mountains. 2. The region of the eastern coasts of Sweden, to the east of the mountains. And, 3. The region of the west coasts of Finland, along the Gulf of Bothnia. Baron Von Buch has made us acquainted with the atmospherical constitution of these three different regions, in which the slowest increase of the winter cold is felt from Drontheim to the North Cape, on the west and north-west coasts. At the Isle of Mageroe, (in north lat. 82°,) at the northern extremity of Europe, under the parallel of 71°, the winters are still 7°.2 milder than at St Petersburg, (in north lat. 38°.8,) but the mean heat of the summers never reaches that of the winters of Montpellier, (in north lat. 59°.4). At the Faroe Isles, under 62° of north lat. the lakes are very seldom covered with ice, and to so temperate a winter succeeds a summer, during which snow often falls upon the plains. Nowhere without the tropics is the division of the annual heat among the seasons more equal. In the temperate zone, under parallels nearer to our own, Ireland presents an ex-

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part of the ocean, and during a long rainy winter, with the sky almost always clouded, the surface of the earth is less cooled by radiation than farther to the east, in the interior of the country, where the atmosphere is pure and dry.

	Lat.	Mean Temperature.		
		Year.	Winter.	Summer
Franecker,	52° 36′	51°.8	36°.7	67°.3
Amsterdam,	52 22	53.4	36.9	65.8
Hague,	52 3	51.8	38.3	65.5
Rotterdam,	51 54	51.1	36.9	64.9
Middelburg,	51 30	49.6	36.1	64.0
Dunkirk,	51 2	50.5	38.5	64.0
Brussels,	50 50	52.0	36.7	66.2
Arras,	50 17	49.4	35.8	63.3
Cambray,	50 10	52.0	39.0	66.6

The mean duration of the observations at each place is from eight to nine years, and 52,000 partial observations have been employed to obtain nine mean temperatures. A similar [illegible]ony in the results is also found in Lombardy.

			Mean Temp.
Milan,	[illegible]	Bologna,	56°.3
Padua,	[illegible]	Venice,	56.5
Verona,	[illegible]		

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ample still more striking of the union of very mild winters, with cold and moist summers. Notwithstanding a difference of 4° of latitude, the winters there are as mild as in Britain, while the mean temperature of the summers is three degrees less. This is the true maritime climate. The month of August, which on the same isothermal line, in the east of Europe [*], (in (Hungary) has the temperature of 71°.6, reaches only 60°.8 at Dublin. The month of January, whose mean temperature at Milan, and in a great part of Lombardy, is only 35°.6, rises in Ireland to 5°.4, and 7°.2. On the coasts of Glenarm, also (in north lat. 54° 56′,) under the parallel of Konigsberg, the myrtle vegetates with the same strength as in Portugal [†]. It scarcely freezes there in winter, but the heat of summer is not capable of ripening the vine.

These examples are sufficient to prove, that the isocheimal lines deviate much more than the isothermal lines from the terrestrial parallels, In the system of European climates, the latitudes of two places that have the same annual temperature cannot differ more than from 4° to 5°, while two places whose mean winter temperature is the same, may differ more than 9° or 10 in latitude. The farther we advance to the east, the more rapidly do these differences increase.

The lines of equal summer, or *isotheral curves*, follow a direction exactly contrary to the *isocheimal lines*. We find the same summer temperature at Moscow, in the centre of Russia, and towards the mouth of the Loire, notwithstanding a difference of 11° of latitude. Such is the effect of the radiation of the earth on a vast continent deprived of mountains. It is sufficiently remarkable, that the inflexions of the isothermal lines, and the division of lands and seas are such upon the globe, that every where in North America, in Europe, and in Eastern Asia, the mean temperature of the summers does not denote more than 36° in the parallels of from 45° to 47°. The same causes which in Canada, and in the north of China, sink the curves of equal annual heat, where the isothermal lines (those of

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[*] Wahlenberg *Flora Carpath*. p. 90.

[†] *Irish Transactions*, tom. viii. p. 116, 203, 269.

51°.8, and 53°.6,) corresponding to the parallels of 45° and 47°, tend to raise the lines of equal summer or the *isotheral curves.*

However great be the influence of the unequal division of the heat between the seasons, on the physical condition of nations, on the developement of agricultural industry, and the selection of plants for culture, I would not recommend the tracing upon the same chart the isothermal lines, and the winter and summer curves. This combination would not be more fortunate than the lines of declination, inclination, and equal intensity of the magnetic forces, which, however, all depend upon one another. Instead of multiplying the intersection of the curves, it will be sufficient to add to the isothermal lines, near their summits, the indication of the mean temperatures of summer and winter. In this way, by following the line of 50°, we shall find marked in America, to the west of Boston, $\left(\frac{30^\circ.2}{73^\circ.4}\right)$, in England $\left(\frac{37^\circ.4}{62^\circ.6}\right)$, in Hungary $\left(\frac{31^\circ.1}{69^\circ.8}\right)$, and in China $\left(\frac{23^\circ.0}{78^\circ.8}\right)$.

(To be continued.)

ART. IX.—*Account of the Descent of the Glacier of the Weisshorn, on the 27th December* 1819, *and the Destruction of the Village of Randa* *.

THE village of Randa is situated about six leagues above Vispach, on the southern or right branch of the valley of Vispach, known under the name of the Valley of St Nicholas. The valley is about 2400 feet from the right bank of the Visp, on the steep declivity of a hill of debris, whose stony soil has been converted into meadows by the industry of the inhabitants of Randa. Opposite to this hill is another of the same kind, above which are the rocks that are covered by the Glacier of Randa, whose highest summit, called the Weisshorn, rises about 9000 fee [illegible] village. The width of the valley, at the height of the village, nearly 250 feet above the river, is nearly half a league.

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* Translated fro [illegible] *Universelle*, Feb. 1820. p. 150. and taken from the official re [illegible] gineer to the Council of State of the Valais.

On the 27th December 1819, at six o'clock in the morning, towards the eastern and most rugged side of the highest peak of the Weisshorn, a part of the glacier which covers it having become loose, precipitated itself with the noise of thunder on the mass of ice below, and announced, by the most frightful crash, the ravages which threatened the valley. At the instant when the snow and ice struck the inferior mass of the glacier, the pastor of the village, the sacristan, and some other persons, observed a light *, which almost immediately disappeared, and left every thing enveloped in the darkest night. A frightful hurricane, occasioned by the pressure of the air, immediately succeeded, and in an instant produced the most tremendous devastation. The precipitated masses of ice did not reach the valley, but the hurricane occasioned by their fall was so violent, that it carried substances several toises up the mountains; tore up by the roots the largest larch trees at great distances; projected blocks of ice of some cubic feet beyond the village to the distance of half a league; carried away the spire of the steeple; levelled several houses with the ground, and carried the carpentry of several edifices more than a quarter of a league beyond the village, into the forest which lies above it. Eight goats, which were in a stable, were whirled to the distance of several hundred toises, and, what was very singular, one of them was found alive. At the distance of more than a quarter of a league above the village, the barns opposite the glacier were completely unroofed.

Upon the whole, nine houses in the village were totally destroyed, and the other thirteen more or less damaged; eighteen granaries, eight small dwelling houses, two mills, and 72 barns, are either destroyed, or so much injured as to be of no use. The crops, too, are almost totally lost, both for man and beast. Out of twelve persons overwhelmed by this cata-

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* It would be desirable to have a satisfactory explanation of this phenomenon, which, in so far as we know, has not been observed in similar cases, and which, in the darkness of the night, was too striking to be attributed to any illusion.—Orig.

We have no hesitation in considering the light here mentioned as electrical, and as analogous to that which is developed by breaking crystallised sugar, &c—Ed.

strophe, ten are still alive, the eleventh was taken out dead, and the twelfth has not yet been found.

The avalanche, consisting of a mixture of snow, ice *, and stones, covers the fields and the meadows below the village for the length of at least 2400 feet, and for a width of 1000. The mass which has descended is nearly 150 feet high; so that the whole body of ice precipitated is about 360,000,000 cubic feet. The amount of the damage has been estimated at 20,000 francs.

It is a remarkable circumstance attending this event, that some barns on the other side, below the glacier, and which the avalanche had almost covered, remained uninjured, and were never touched by the hurricane; but, what is still more difficult to conceive, two persons only have lost their lives in this disaster, although several families were carried away with their houses, and buried in their ruins, and in the wreaths of snow. The prompt assistance afforded by the pastor, who did not suffer personally, and of the two sacristans who escaped, contributed to save several lives.

This is not the first time that the village of Randa has experienced a disaster of this nature. In 1636 it was destroyed by a similar avalanche, by which 36 persons lost their lives. It is said that the whole glacier of Weisshorn then fell. Two other avalanches, less considerable, took place in 1736 and 1786, but not exactly in the same place.

On the present occasion, only a small part of the glacier fell down; and it is difficult to conceive how the remainder, deprived of its support, can be sustained. Enormous clefts can be perceived in it by good telescopes, and these had been long ago noticed by the chamois hunters. The part of the glacier which has fallen is said to have been separated from the rest by similar clefts. There is therefore great reason to dread, that the glacier cannot much longer maintain itself upon this steep ridge, and that the rest of the village of Randa may be completely destoyed by the avalanche which still threatens it. No human skill can prevent this catastrophe, and therefore the inhabitants of the unfortun [illegible] mmune must either fortify themselves

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* M. Venetz rem [illegible] itated blocks consisted chiefly of a mixture of ice in grains, [illegible] ence it appears that the glacier was at an elevation where th [illegible]

PLATE IX.

Edin^r. Phil. Jour. Vol. III. Page 277.

Fig. 9.

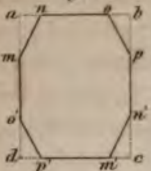


Fig. 1.

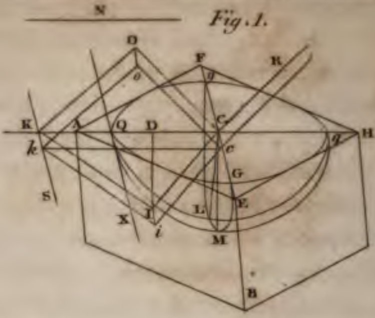


Fig. 10

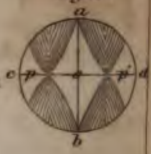


Fig. 2.

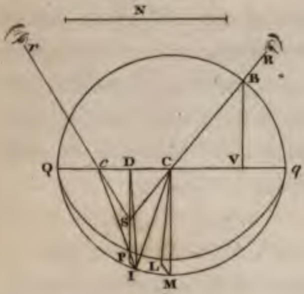


Fig. 3.

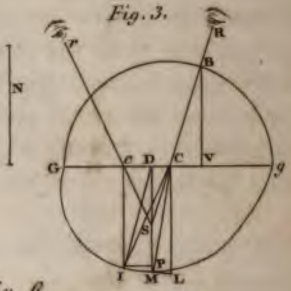


Fig. 6

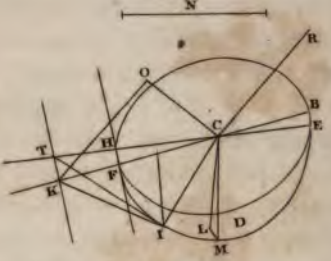


Fig. 4.

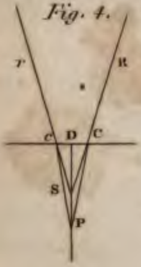


Fig. 5.

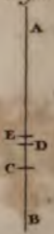


Fig. 11.

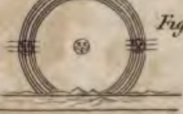


Fig. 7.

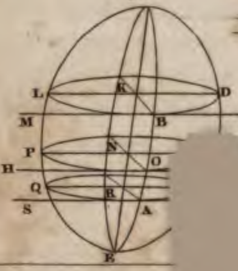
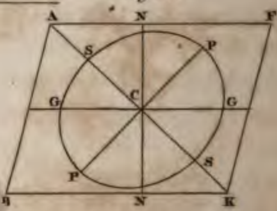


Fig. 8.



W. H. Lizars Sculp^t.

P [illegible] Constable & C^o. 1820.

against the danger, or quit their habitations. The most obvious mean of defence, is the erection of a high and strong rampart, which would resist the influence of the hurricane; but this rampart, by preventing the circulation of air, might render the village of Randa still more insalubrious, and more subject to cretinism than it actually is, and it is still doubtful, whether or not this wall would shelter them from the storm.

It might therefore be more advisable to abandon the place, and in order that the inhabitants might not be removed far from the meadows, it would be necessary to rebuild the village about half a league farther up, towards Tesch. The poor inhabitants, however, cannot adopt either of these methods of safety, unless the Government, and the other communes of the canton, afford them the necessary assistance.

ART. X—*Historical Account of Discoveries respecting the Double Refraction and Polarisation of Light.* (Continued from Vol. III. p. 154.)

PERIOD II. *Containing an Account of Huygens' Theory of Double Refraction.* Concluded from Vol. iii. p. 154.

IN the section of the crystal which has hitherto been considered the unusually refracted ray, lies in the plane which passes through the incident ray, and cuts the surface of the crystal at right angles. In all other sections, however, the refracted ray is turned out of this plane.

In order to explain the cause of this, let ABH, Fig. 1. Plate IX. be a perfect rhomb of the spar, so that the obtuse angles are bisected by the line EF, and the acute angles by AH perpendicular to EF.

Let the ray RC be incident in the plane which passes through AH, and let C be conceived to be the centre of a hemi-spheroid, QG $q\,g$ M, by which the light is propagated in the crystal, and whose section by the plane AEHF forms the ellipse QG $q\,g$, whose greater diameter Q q in the line AH, will be one of the great diameters of the spheroid; for since the axis of the spheroid is in the plane passing through FEB, to which QC is perpendicular, it follows that QC is also perpendicular to the axis of the spheroid, and consequently QC q one of its great diameters. The smaller diameter G g of this ellipse will be to Q q as CG to CP, that is as 98779 to 105032. (See this volume, p. 150, par. 2.)

Let N be the space described by the light in air, while in the crystal from the centre G, it forms the spheroid QG q g M, then having drawn CO perpendicular to CR, and in the plane passing through CR and AH, let OK be taken equal to N, and at right angles to CO, so as to meet AH in K. Drawing CL perpendicular to the surface of the crystal at C, and supposing CM to be the refraction of the ray which falls perpendicularly on the surface, let there be drawn a plane through the line CM and KCH, making in the rhomboid the semi-ellipse QM q, which will be given since the angle MCL is known to be 6° 40′. Now, a plane touching the spheroid at the point M will be parallel to the plane QG q, (See this vol. p. 150. par. 2.) If, therefore, through the point K we draw KS parallel to G g, and consequently to QX, a tangent to the ellipse QG q in Q, and conceive a plane passing through KS, and touching the spheroid, the point of contact will necessarily be in the ellipse QM q, because the plane passing through KS, and the plane which touches the spheroid at the point M are parallel to QX the tangent, as appears from the Lemma in the note upon page 282. Since this point of contact is in I, then making KC, QC, DC proportionals, drawing DI parallel to CM and joining C and I, CI will be the refraction of the ray RC. All this will be manifest, if, in considering CO perpendicular to RC, as a portion of a wave of light, we can demonstrate that the continuation of its place at C is found in the crystal at I when O arrives in K.

If we take C c as the width of a portion of the wave, let the rectangles CO o c be considered as a portion of the wave, and let the rectangles CK k c, CI i c, KI i k, OK k o be completed. When O o has arrived at K k, all the points of the wave CO o c will [redacted] rrived at the rectangle K c, by lines parallel to OK, an ints of their incidence there are formed in the crys emispheroidal waves similar, and similarly situa pheroid QM q, all of which necessarily touch the plane of the parallelogram KI *i k* at the same instant that O *o* comes to K *k*. This is easily understood, since such of these hemispheroids as have their centre along the line CK touch this plane in the line KI, (which is demonstrated in the same manner as we have done that of the oblique ray in the principal section through EF,) and such of them as have their centres in the line C *c* touch the same plane K *i* in the line I *i*, being all those that are similar to the hemispheroid QM *q*. Since, then, the rectangle K *i* is that which touches all the spheroids, it will be the continuation of the wave CO *oc* in the crystal when O *o* has arrived in K *k*, on account of the termination of the motion, and the quantity of it which is there greater than any where else. Hence it appears that the point C of the wave CO *o c* has its continuation in I, that is, that the ray RC is refracted into CI.

As the proportion of the refraction for this section of the crystal, is that of the line N to the semidiameter CO, the refraction of all incident rays may be easily found in the same way as we have already shewn for the section through FE, and the demonstration will be the same. This proportion, however, is less here than in the section through FEB; for it was as N to CG, that is as 156962 to 98779, or nearly as 8 to 5, whereas it is there as N to CQ, half the great diameter of the spheroid, or 156962 to 105032, or nearly as 3 to 2, a result agreeing perfectly with observation.

This difference in the ratios of refraction produces a very singular effect. When the crystal is placed on paper, containing letters or any other mark, the image formed by the unusual refraction appears more elevated when the two eyes are in the plane of the section EF, than when they are in the section AH, and the difference of these elevations appears from the ordinary refraction, whose ratio is as 5 to 3, which always raises the letters equally, and higher than is done by the irregular refraction. For the letters, and the paper on which they are written, appear as on two different stages at the curve line, and when the eyes are in the plane AH, these two stages are four times more distant from one another than when the eyes are in the plane EF.

In order to shew the cause of this, let the plane of Fig. 2, Plate IX. represent the section through AH, or Q *q* and CL, in which section is the ray RC. Let the semielliptical plane passing through Qq and CM be inclined to the first at 6° 40′, and, therefore, the refracted ray CI is in that plane. Then, if I, a point in the bottom of the crystal is seen by the rays ICR, Icr refracted equally at C, c, and, therefore, equidistant from D, and reaching the eye at R, r, the point I must appear raised to S, the intersection of R, C, rc, and in the line DP perpendicular to Qq. If IP is then drawn perpendicular to DP, SP will be the apparent elevation of I above the bottom of the crystal.

Let there be described upon Qq a semicircle cutting CR in B; let BV be drawn perpendicular to Qq, and let the proportion of the refraction for this section be that of N to CQ. Then

$N : CQ = VC : CD$. But
$VC : CD = VB : DS$. Here
$N : CQ = VB : DS$.

Let ML be drawn perpendicular upon CL, and because the eyes at R and r are supposed to be about a foot from the crystal, and the angle RSr very small, we may consider $VB = CQ$ and $DP = CL$, whence $N : CQ = CQ : DS$. But $N = 156962$, CM being 100000 and $CQ = 105032$, consequently, $DS = 70283$. But $CL = 99324 = \cos MCL$, or 6° 40′, CM being radius. Hence, $DP : DS = 99324 : 70283$, which gives the elevation of the point I by refraction.

Let us now consider what takes place in the other section EF, Fig. 1. Let GMg, Fig. 3. be the semiellipse already considered in Vol. iii. p. 150. par. 2. and 3., and which is formed by a section of a spheroidal wave, having C for its centre. Let the point I be seen as before by the eyes at R and r, and CR and cr being equally inclined to the surface of the crystal. Drawing CI parallel to CM, the refraction of a perpendicular ray, DC and Dc will be equal, (See Vol. iii. p. 150. par. 3.) The point I will obviously appear at S in the line DP, and if IP is drawn perpendicular to DP, PS will be the elevation of the point I. Let there be described upon Gg a semici [illegible] CR in B, let BV be drawn perpendicular to Gg, [illegible] io of refraction in this section be that of N to [illegible] is the refraction of BC and DI parallel to C [illegible] y Vol. iii. p. 150. par. 1.

VC : CD = N : GC, but VC : CD = BV : DS. Let ML be drawn perpendicular to CL, then, as formerly, we may consider BV = CG, and DS a third proportional to N and CG. Hence, DP = CL. But since CG = 98778, CM being 100000, N is = 156962. Whence DS = 62613, but CL = 99324, consequently PD : DS = 99324 : 62163, and, therefore, the elevation of I by refraction is known, and is greater than in the section AH, Fig. 1.

But by the regular refraction of the crystal which was the value of 5 to 3, the elevation of the point I or P will be $\frac{2}{5}$ of DP, as appears from Fig. 4., where P being seen by the rays PCR, P *c r* equally refracted at the surface C *c*, it will appear at S in the perpendicular PD at the intersection of RC, *r c*; and it is known that PC : CS = 5 : 3, since PC : CS = sin CSP or DSC : sin SPC. Since the eyes at R, *r* are supposed to be at a considerable distance above the crystal, we may reckon PD : DS = PC : CS, and, consequently, the elevation PS will also be $\frac{2}{5}$ of PD.

If we take a straight line AB, Fig. 5., for the thickness of the crystal whose bottom is at B, and divide it, in the ratio of the elevation above determined, at the points C, D, E, making A = $\frac{3}{5}$ AB; AB : AC = 99324 to 70283; and AB : AD = 99324 to 62163, these points will be as in the figure, and will accord with the results of observation. That is, when the eyes are in the plane EF, Fig. 1., or the short diagonal of the rhomb, the regular refraction will raise the letters to E, Fig. 5. and the irregular refraction to D; and when the eyes are in the plane AB, Fig. 5. the regular refraction still raising the letters to E, Fig. 1. the irregular refraction will raise them only to C, the elevation CE being quadruple of ED.

In all other positions of the eyes, the unusual image does not appear directly above the usual one, but separates from it, being removed farther from the equilateral solid angle of the crystal. In these cases, the unusual image of P will have an elevation intermediate between BC and BD.

We shall now proceed to point out the method of finding the unusual refraction in all other sections of the crystal beside the two we have considered. Let us take any face of the crystal in which is the ellipse HDE, (Fig. 6.) whose centre is also the centre of the spheroid HME, in which the light is propagated, and of which this ellipse is the section. Let it be required to find the refraction of the incident ray RC.

Through RC draw a plane perpendicular to the plane of the ellipse HDE, cutting it in BCK. In this plane draw CO perpendicular to CR, and draw OK so as to be perpendicular to OC, and equal to N, which is the space described by light in air, while it is propagated in the crystal by the spheroid HDEM, then draw KT perpendicular to BCK, and in the plane of the ellipse HDE, and conceive a plane drawn through KI, and touching the spheroid HME in I, the straight line CI will be the required refraction of RC, as may be easily shewn from the demonstration in p. 277, 278.

In order to determine the point of contact I, let there be drawn HF parallel to KT, and touching the ellipse HDE in any point H. Having drawn CH meeting KT in T, let there be conceived to pass through CH and through CM (the refraction of the perpendicular ray,) a plane which forms in the spheroid the elliptical section HME. Then it is certain by the LEMMA demonstrated below [*], that the plane passing

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[*] LEMMA.—*If a spheroid is touched by a right line, and also by two or more planes parallel to this line, though not to one another, all the points of contact, both of the line, and of the planes will be in the semiellipse formed by a plane passing through the centre of the spheroid.*

Let the spheroid LED, Fig. 7., be touched by the line BM at the point B, and also by planes parallel to this line at the points O and A, we must demonstrate that the points B, O, and A are in the same ellipse, formed in the spheroid by a plane passing through its centre.

Through BM and the points O, A, draw planes parallel to one another, and which, in cutting the spheroid form the similar and similarly situated ellipses LBD, POP, QAQ round their centres K, N, R, in the same diameter of the spheroid, which will also be the diameter of the ellipse made by the section of a plane passing through the centre of the spheroid, and cutting the planes of the three above mentioned ellipses at right angles, all which is manifest from Prop. xv. of Archimedes's book on Conoids and Spheroids. Moreover, the two last planes drawn through O, A will, in cutting the planes which touch the spheroid in these points form straight lines OH, AS, which will be parallel to BM, and all the three, BM [redacted] S, will touch the ellipses LBD, POP, QAQ in the points B, O, A, sinc planes of the ellipses, and at the same time in the planes which If, however, from B, O, A we draw BK, ON, AR through th ellipses, and through these centres, LD, PP, QQ parallel to 1 diameters will be conjugate to BK, ON, AR, and because th similar and similarly situated, and have through KT, and touching the spheroid, will touch it in a point of the ellipse HME. But this point is necessarily the point I which we are seeking, since the plane drawn through TK cannot touch the spheroid in more than one point. This point I is easily determined, since we have only to draw from T, which is in the plane of this ellipse, the tangent TI, in the manner already shewn. For the ellipse HME is given, of which CH and CM are conjugate semidiameters, because a straight line drawn from M parallel to HE touches the ellipse HME; for a plane drawn through M, and parallel to the plane HDE, touches the spheroid in M, as appears from Vol. iii. p. 149, 150. Besides, the position of this ellipse with respect to the plane passing through RC and CK is also given, whence it will be easy to find the position of the refracted ray CI with respect to RC.

We may here observe, that the same ellipse HME serves to find the refractions of every other ray in the plane passing through RC and CK. Because every plane parallel to HF or TK, which shall touch the spheroid, will touch it in this ellipse by the LEMMA already demonstrated.

Huygens next proceeds to shew, that by cutting the crystal in different directions, he found the unusual refraction to be exactly the same as the preceding theory indicated.

In order to explain, says he, what these directions are, let ABKF, Fig. 8. be the principal section through the axis of the crystal ACK, on which will be the axis SS of a spheroidal wave of light, propagated in the crystal from the centre C, and the straight line PP, which bisects SS at right angles, will be one of its great diameters.

But as in a natural section of the crystal, made by a plane GG, parallel to two of its opposite surfaces, the refraction of the surfaces is regulated by the hemispheroids GNG, as has been

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their diameters LD, PP, QQ parallel, their conjugate diameters BK, ON, AR will also be parallel: And the centres K, N, R being in the same diameter of the spheroid, the parallels B,K, ON, AR will be necessarily in the same plane which passes by this diameter of the spheroid, and consequently the points B, O, A will be in the same ellipse formed by the intersection of this plane, which was to be proved. It is manifest that the demonstration would be the same, if beside the points O, A, there were others in which the spheroid was touched by planes parallel to BM.

formerly explained;—so in cutting the crystal through NN, by a plane perpendicular to the parallelogram ABKF, the refraction of the surfaces ought to be regulated by the hemispheroids NGN; and in cutting it through PP perpendicular to the same parallelogram, the refractions will be regulated by the spheroids PSP; and so on with other sections. But I saw, that since the plane NN is almost perpendicular to GG, forming an angle NCG, which towards A is 90° 40′, the hemispheroids NGN become similar to GNG, since NN, GG are both inclined 45° 20′ to the axis SS. Consequently if our theory is true, the surfaces produced by the section NN should have the same refraction as those produced by GG, and so should all other sections inclined 45° 20′ to SS.

I saw likewise, that in cutting the crystal by a plane PP, perpendicular to the axis SS, the refraction of the surfaces ought to be such, that the perpendicular ray suffers none at all, and that oblique rays should always have a refraction different from the regular one, and by which objects placed under the crystal were less elevated than by the other.

In cutting the crystal likewise by any plane passing through its axis SS, like the plane of Fig. 8. I saw that the perpendicular ray ought not to suffer refraction, and that oblique rays should have different measures of the irregular refraction, according to the situation of the plane in which the ray was incident.

In all the directions now mentioned, I have found these effects produced, and I have no doubt that the same successful results will be obtained in every other direction. From which I conclude, that we may form out of this crystal solids similar to those which are natural to it, which will produce in all their surfaces the same *regular* and *irregular* refractions as the natural refractions, but which cleave quite differently, and not parallel to any of their faces. Hence it appears, that it is by no means in the disposition of the plates or strata of which this crystal appears to be composed, and according to which it cleaves in three different dir[illegible] that the cause of the extraordinary refraction resides [illegible] would be in vain to seek for it there.

Remarks on Huygens' Discoveries.

The preceding analysis of the phenomena of double refraction as exhibited in Iceland spar, will always be considered as an example of the fine genius and discrimination of Huygens. By means of the happy idea, that light was propagated through this mineral in spheroidal in place of spherical waves, he was led to a correct generalisation of the phenomena, which possesses a high value, independent of the hypothesis on which it is founded.

Huygens, however, never intended, that the law to which he had referred the double refraction of Iceland spar, should be considered as the law of double refraction. On the contrary, he maintains, that he had found, by direct experiment, that the only other doubly refracting crystal with which he was acquainted, namely, *Rock Crystal, had its double refraction regulated by an entirely different law, the light being propagated through it in two spherical waves, one of which was a little slower than the other*[*]. This result was obtained, by cutting prisms of rock-crystal in different directions, and is mentioned in his Preface, as a new remark which he had made after the first copy of his treatise had been communicated to some of the Members of the Academy of Sciences. Huygens, therefore, proposed two different laws of double refraction, the one for Iceland spar, and the other for Rock-crystal. The last of these, founded on incorrect observations, has no existence in nature; while the first represents the phenomena of Iceland spar, within the limits of the errors of observation.

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[*] As this passage is very interesting, we shall give it in his own words.

"La double emanation d'ondes de lumière, que je m'estois imaginée, me devint plus probable apres certain phenomene que j'observay dans la crystal ordinaire (Rock crystal), qui croit en forme hexagone, et qui, à cause de cette regularité, semble aussi estre composé de particules de certaine figure, et rangées avec ordre. C'estoit que ce cristal a une double refraction, aussi bien que celuy d'Island, quoyque moins evidente. Car, en ayant fait tailler des prismes bien polis, par des sections differentes, je remarquay dans tous, en regardant la flame de la chandelle à travers, ou le plomb des vitres qui sont aux fenetres, que tout paroissoit double, quoyqu' avec des images, peu distantes entre elles.

"Or, cette double refraction, suivant ma theorie cy dessus etablie, sembloit *demander une double emanation d'ondes de Lumiere tout deux spheriques (car les deux refractions sont regulieres), et les unes seulement un peu plus lentes que les autres.*" *Traité de la Lumiere*, chap. v. § 20, 21.

ART. XI.—*On the Temperature of the different Mines in America*[*]. By Baron ALEXANDER DE HUMBOLDT.

Mines of New Spain.

GUANAXUATO is situated in latitude 21° 0′ 15″, and the height of the plain is about 1100 toises above the level of the sea. The mean temperature of the air is probably 60°.8 of Fahrenheit. The mine of Valenciana is so warm, that in the deepest parts the miners are constantly exposed to a temperature of 91°.4.

	Temperature.	Depth in Feet.
In September the air without the mine was	66°.7	
Between *Despacho del tiro Nuevo* and *Boveda de San Pablo*,	74°.7 81°.7	273 546
In the *Levels (Planes) of San Bernardo*,	92°.8	1638

The spring which comes from the same veins at the depth of 1638 feet, has a temperature of 98°.2, and is 5°.4 warmer than the air of the levels *(planes)* in which the miners work [†].

The mine of Rayas, near that of Valenciana, is erroneously regarded by the miners as much warmer than the levels of San Bernardo. I have found the thermometer,

	Temperature.	Depth in Feet.
Near the *Boca de la Mina*,	69 .4	0
In the levels,	92°.7	630

In the mines of Villalpando, three leagues to the north of Guanaxuato, on a plateau of 1330 toises, I have found the thermometer,

	Temperature.	Depth in Feet.
In the open air,	72°.3	0
In the levels,	84 .9	436

It was in the mines of Guanaxuato that there was heard, in 1784, a subterranean noise, unattended with any shock. The volcano of Jorullo, which broke out of the earth on the 14th

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[*] These observ[illegible] been just published in the *Annales de Chim.*, tom. xiii. p. 207, fr[illegible] journals of M. Humboldt.

[†] In the *Nivell*[illegible] *des Andes*, No. 336, the temperature of the spring is said to [illegible]eas it is 36°.8 Cent. or 98°.2 of Fahrenheit.

September 1759, is fifty leagues distant from the metalliferous transition rocks of Guanaxuato. There are warm springs around Guanaxuato which issue from a basaltic conglomerate. Those of Comangillas which I have examined, have 205°.1 of temperature.

The mine of Cabrera, near Moran, (latitude 20° 10′ 4″) has an altitude of 1331 toises, and a mean annual temperature probably of 60°.4. I found

	Temperature.	Depth in Feet.
The external air, - - - -	50° to 53°.2	0
In the Gallery *del Conde de Regla*, without any traces of metal in the transition porphyry,	70°.2	164
Subterranean water at this place, - -	62°.8	164

In the village of Tehuilotepec near Tasco, where the latitude is 18° 35′ 0″, its altitude 919 toises, and the mean annual temperature, probably 68°, I have found the thermometer,

	Temperature.	Depth in Feet.
Out of the mine in the day-time, - -	80°	0
Ditto, during the night, - - -	61°.7	0
In the Gallery of *San Ignacio*, where there was no miner, and no current of air,	75°.7	354
In the water of the mines at the same place, -	68°	354

At Moran, the waters of the mines was 7°.2 colder, and at Tehuilotepec 7°.7 colder than the air of the mines *.

Mines of Peru.

The only observations made at great depths, but in parts of the globe raised more than 1800 toises above the level of the sea, are those of Hualgayoc, near Micuipampa, on the back of the Andes of Chota, in south latitude 6° 43′ 38″. The height of the plateau is 1816 toises, and the mean annual temperature of the air at this height is probably 46°. The metalliferous mountain of Hualgayoc, which is insulated in the plateau, appears to be more than 2100 toises above the level of the ocean. I found the thermometer to stand thus:

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* In the mines of St Ana, in the kingdom of New Granada, I have found the air of the interior every where 70°.5, when the air without was in the day-time 72°.5, and in the night 65°.7, but the depth of the mine was scarcely thirty-five toises. It is situated in 5° 10′ of north latitude, has 500 toises of height, and is in a region whose mean annual temperature is probably from 69°.8 to 71°.6.

	Temperature.	Depth in Feet.
In the open air, - -	9° to 10°.8	0
In the *Mina de Guadalupe*, -	57 .7	unknown.
Water of the mine, - -	52 .2	

In the *Mina Purgatorio*, which is extremely dry, the air was 67°.3. Such a temperature in the interior of the earth, and almost at the height of the Peak of Teneriffe, is undoubtedly very remarkable. The thermometer in these countries stands at from 41° to 48° in the day-time, and from 32°.7 to 35°.6 in the night. The point where I measured the temperature at Purgatorio, is nearly thirty toises lower than that of Guadalupe. It is almost impossible to determine the depth relative to the surface of the earth, because the insulated mountain in which the mines are wrought, has a very irregular declivity. It is sufficient to recollect that the levels of the two mines are a little above the level of the Plateau of Micuipampa, and from 250 to 300 toises below the summit of the Mountain Hualgayoc.

Two points in the interior of this mountain of 1840 toises of absolute height, have therefore 57°.7 and 67°.3 of temperature. When the surrounding air has a mean temperature of 46°, the water of the mines is in the same places 52°.2.

ART. XII.—*On the Ellipticity of the Earth.* By WILLIAM WATTS, Esq. Communicated by the Author.

PROBLEM. TO determine the ellipticity of the Earth, and the increase of gravity from the equator to the poles, on the hypothesis, that the greatest error in the observations of the lengths of the seconds' pendulum, is less than in every other elliptical figure, assuming for data the observations of the lengths of the seconds' pendulum, made by Captain Kater, at the different points of the British meridian, from Unst to Dunnose, as stated i table published in this Journal, vol. ii. p. 321 *.

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* In Captain Kate pendulum, ordered by the House of Commons to be print ondon in a mean solar day are stated at 86059.21.

In order to find the elliptical figure of the earth, in which the greatest deviation in the measures of the lengths of the seconds' pendulum is less than in every other elliptical figure, it will be requisite to seek such values of the unknown quantities involved in the problem, as correspond in the best manner possible with the whole of the observations. This is what MM. Mathieu and Biot have done, by means of the method of least squares; and I shall adopt the same method in the following investigation, on account of its superior advantages over every other mode of computation, in questions of this nature.

Let l_1, l_2, l_3, &c. represent the lengths of the seconds' pendulum, as determined upon the different points of the British meridian; let s_1, s_2, s_3, &c. denote the squares of the sines of the corresponding latitudes; suppose that in the ellipse sought, the length of the seconds' pendulum is expressed by a function of the form $l = x + y \sin^2 \mathrm{L}$, or $l = x + s\,y$; in which equation x represents the length of the seconds' pendulum at the equator, where the latitude L is nothing; and y is the excess of the length of the seconds' pendulum at the pole, above that at the equator: since in the elliptical hypothesis, the length of the pendulum is known to vary, as the square of the sine of the latitude; then by calling the errors of observations, z_1, z_2, z_3, &c. we shall have the following equations of condition:

$$
\begin{aligned}
l_1 - x - s_1 \cdot y &= z_1, \\
l_2 - x - s_2 \cdot y &= z_2, \\
l_3 - x - s_3 \cdot y &= z_3, \\
\cdot\ \cdot\ \cdot\ \cdot\ \cdot\ &\cdot\ \cdot\ \cdot\ \cdot \\
l_n - x - s_n \cdot y &= z_n
\end{aligned}
$$

for if we compute the values of s_n, or $\sin^2 \mathrm{L}$, for each of the places where the observations were made, the formula . . . . . . $x + y \sin^2 \mathrm{L}$, will represent, in each place, the length of the seconds' pendulum; then if we subtract this expression from the observed length of the pendulum, the difference z will represent the error of the elliptic hypothesis.

By proceeding in this manner, with the results of the observations at each station, as specified in the preceding table, we shall form the seven following equations of condition:

$$
\begin{aligned}
39{,}17146 - x - 0{,}76136670 \cdot y &= z_1, \\
39{,}16159 - x - 0{,}71419880 \cdot y &= z_2,
\end{aligned}
$$

$$39{,}15554 - x - 0{,}68694728 \cdot y = z_3,$$
$$39{,}14600 - x - 0{,}64556764 \cdot y = z_4,$$
$$39{,}14250 - x - 0{,}62460442 \cdot y = z_5,$$
$$39{,}13929 - x - 0{,}61280052 \cdot y = z_6,$$
$$39{,}13614 - x - 0{,}59751663 \cdot y = z_7.$$

Now, by the principle of least squares, the values of x and y ought to be determined in such a manner, that the sum of the squares of the errors z_1, z_2, z_3, &c. may be the least possible: and to satisfy this condition, it will be requisite to form the equations of *minimum* for each of the unknown quantities x and y, in particular, by multiplying all the terms of each of the equations of condition by the coefficient of the unknown quantity, taken with its proper sign, and then find the sum of all the products.

By performing this operation successively, with each of the coefficients of the unknown quantities, upon all the equations of condition, we shall obtain as many different equations as there are unknown quantities. These equations will all be of the first degree, and it will only remain to determine the unknown quantities by the ordinary process of elimination.

Then the values of x and y, determined in this manner, will be the most proper to represent the best possible observations, since they will give a system of errors which differs less from the truth than any other system whatever.

Since, therefore, the coefficient of x is unity in all the equations of condition, the equation of minimum relatively to x will be found, by taking one-seventh of their sum, and putting the quotient equal to zero: Thus we shall find,

$$-39{,}15036 + x + 0{,}66328595 \cdot y = 0 \;\ldots\ldots\; (1.)$$

In like manner, if we multiply each equation of condition by the coefficient of y in that equation, the following results will arise,

$$-29{,}8238492 + x \cdot 0{,}76136670 + y \cdot 0{,}57967933$$
$$-27{,}9691673 + x \cdot 0{,}71419880 + y \cdot 0{,}51008004$$
$-26{,}897$ [illegible] $,68694728 + y \cdot 0{,}47189664$
$-25{,}271$ [illegible] $4556764 + y \cdot 0{,}41675753$
$-24{,}44$ [illegible] $460442 + y \cdot 0{,}39013081$
$-23{,}984$ [illegible] $280052 + y \cdot 0{,}37552451$
$-23{,}384$ [illegible] $51630 + y \cdot 0{,}35702582$:

the sum of all these quantities being divided by 7, and the aggregate result made equal to zero, we shall obtain

$$-25{,}9685258 + 0{,}66328595 \,.\, x + 0{,}44301352 \,.\, y = 0 \,\ldots\, (2).$$

This is the equation of *minimum*, with respect to y; and if we eliminate y from the equations (1) and (2), we shall find

$$0{,}2058309 - 0{,}00525132 \,.\, x = 0; \text{ whence we deduce}$$

$$x = 39{,}0135648\,.$$

This is the length of the seconds' pendulum at the equator; and by substituting this value of x in the equation (2), we shall have,

$$y = 0{,}20626348\,;$$

therefore, in general, the absolute length of the seconds' pendulum, as deduced from the preceding experiments of Captain Kater, will be

$$l = 39{,}0135648 + 0{,}20626348 \sin^2 L\,.$$

This formula gives for the length of the seconds' pendulum, in the latitude of London, 39,1399631 inches of Sir G. Shuckburgh's scale.

Hence it follows, that the ratio $\frac{y}{x} = 0{,}00528697$, will express the total lengthening of the seconds' pendulum from the equator to the pole, or which is all the same, the total increase of gravity.

But *Clairault* has demonstrated, in his excellent work on the Figure of the Earth, that, in every hypothesis relative to the interior nucleus covered by the ocean, the sum of the total increase of gravity, from the equator to the poles, determined as above, together with the earth's ellipticity, is always the same, and equal to five halves of the ratio of the centrifugal force, to the force of gravity at the equator; that is to say, this sum is equal to $\frac{1}{115\frac{3}{5}}$, or 0,0086505188. If, therefore, we call the ellipticity C, we shall have

$$C + 0{,}00528697 = 0{,}0086505188,$$

$$C = 0{,}003635488\,;$$

or, by reversing the fraction,

$$C = \frac{1}{297{,}305}, \text{ the required compression of the earth.}$$

This value differs very little from $\frac{1}{297,7}$, the compression which M. Biot has deduced from the observations that have been made upon the different points of the French meridian, from Formentera to Dunkirk. But by correcting the latitudes of Formentera and Clermont, which latitudes are stated to be 38° 39′ 46″, and 46° 48′ 4″ respectively, see "*Astronomie Physique*," par Biot, tom. iii. p. 164., instead of 38° 39′ 57″ 1, and 45° 46′ 44″, we shall deduce from the same observations the compression $\frac{1}{296,26}$, which, however, is not materially different from the compression computed by M. Biot himself.

Hence it appears, that the mean compression thus deduced from the observations which have been made on the lengths of the seconds' pendulum, at different points of the terrestrial meridian, from Formentera to Unst, comprising an arc of the meridian equal to 22° 5′ 42″, or nearly one-fourth part of the terrestrial quadrant, amounts to $\frac{1}{296,782}$.

It may not be improper to remark, that the compression $\frac{1}{297,305}$, agrees, very nearly, with two inequalities in the lunar motions; the first, depending on the longitude of the moon's node, and amounting to 20,987 decimal seconds, according to M. Burg, corresponds with the oblateness $\frac{1}{305,05}$.

The second, depending on the sine of the true longitude of the moon, and resulting from a nutation in the lunar orbit, produced by the action of the terrestrial spheroid, and corresponding with that which the moon produces on the terrestrial equator, in such a manner, that one of these nutations is the reaction of the other; so that if all the particles of the earth and moon were rigidly connected together by inflexible straight lines, without mass, the entire system would be *in equilibrio* round the centre of gravity of the earth, in virtue of the forces which produce the [illegible] nutations. M. Burg has determined the coefficient of [illegible] by a great number of observations, and found i[illegible] 4,6914 decimal seconds; this inequality corresponds with the compression $\frac{1}{304,0}$, *Vid. Mecan. Celeste*, tome iii. pp. 173, & 174.

These two inequalities merit the attention of observers; since they possess an advantage over the measures of the degrees of the meridian, and the observations of the lengths of the seconds' pendulum, inasmuch as they give the oblateness of the earth, in a manner less dependent on the irregularities of its figure.

PENZANCE, 17*th June* 1820.

ART. XIII.—*Account of the Family of Sir Isaac Newton*, in a Letter from the late THOMAS REID, D. D. Professor of Moral Philosophy, Glasgow, to the late JOHN ROBISON, LL. D. F. R. S. E. Professor of Natural Philosophy in the University of Edinburgh [*].

DEAR SIR,

I AM very glad to learn by yours of April 4, that a Mr Barron, a near relation of Sir Isaac Newton, is anxious to enquire into the descent of that great man, as the family cannot trace it farther, with any certainty, than his grandfather. I therefore as you desire, send you a precise account of all I know, and am glad to have this opportunity, before I die, of putting this information in hands that will make the proper use of it, if it shall be found of any use.

Several years before I left Aberdeen, (which I did in 1764), Mr Douglas of Fechel, the father of Sylvester Douglas, now a barrister at London, told me, that having been lately at Edinburgh, he was often in company with Mr Hepburn of Keith, a gentleman of whom I had some acquaintance, by his lodging a night at my house, at New Machar, when he was in the rebel army, in 1745. That Mr Hepburn told him, that he had heard Mr James Gregory, professor of mathematics, Edinburgh, say, that being one day in familiar conversation with Sir Isaac Newton at London, Sir Isaac said, "Gregory, I believe you do'nt know that I am a Scotchman." "Pray, how is that?"

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[*] This interesting letter, which we have copied from the original, has been kindly transmitted to us by John Robison, Esq. F. R. S. E. who found it among his father's MSS.—ED.

said Gregory: Sir Isaac said he was informed that his grandfather (or great-grandfather), was a gentleman of East (or West) Lothian: that he went to London with King James I. at his accession to the Crown of England: and that he attended the Court in expectation, as many others did, until he spent his fortune, by which means his family was reduced to low circumstances. At the time this was told me, Mr Gregory was dead, otherwise I should have had his own testimony, for he was my mother's brother. I likewise thought at that time, that it had been certainly known that Sir Isaac was descended of an old English Family, as I think is said in his *eloge* before the Academy of Sciences at Paris, and therefore I never mentioned what I had heard for many years, believing that there must be some mistake in it.

Some years after I came to Glasgow, I mentioned (I believe for the first time), what I had heard to have been said by Mr Hepburn, to Mr Cross, late sheriff of this county, whom you will remember. Mr Cross was moved by this account, and immediately said, "I know Mr Hepburn very well, and I know he was intimate with Mr Gregory: I shall write him this same night, to know whether he heard Mr Gregory say so or not." After some reflection, he added, "I know that Mr Keith, the Ambassador, was also an intimate acquaintance of Mr Gregory, and as he is at present in Edinburgh, I shall likewise write to him this night."

The next time I waited on Mr Cross, he told me that he had wrote both to Mr Hepburn and Mr Keith, and had an answer from both, and that both of them testified that they had several times heard Mr James Gregory say, that Sir Isaac Newton told him what is above expressed; but that neither they nor Mr Gregory, as far as they knew, ever made any farther inquiry into the matter. This appeared very strange both to Mr Cross and me, and he said he would reproach both for their indifference, and would make inquiry as soon as he was able.

He lived but a short time after this, and in the last conversation I had with hi the subject, he said, that all he had yet learned was, is a Sir John Newton of Newton, in one of t Lothian, (but I have forgot which), some of ere yet alive: That they reported that their , had a letter from Sir Isaac

Newton, desiring to know the state of his family, what children he had, particularly what sons, and in what way they were. The old proud knight never returned an answer to this letter, thinking probably that Sir Isaac was some upstart, who wanted to claim a relation to his worshipful house. This omission the children regretted, conceiving that Sir Isaac might have had a view of doing something for their benefit.

After this, I mentioned occasionally in conversation what I knew, hoping that these facts might lead to some more certain discovery ; but I found more coldness about the matter than I thought it deserved. I wrote an account of it to Dr Gregory, your colleague, that he might impart it to any member of the Antiquarian Society, who, he judged, might have the curiosity to trace the matter farther.

In the year 1787, my colleague, Mr Patrick Wilson, professor of astronomy, having been in London, told me on his return, that he had met accidentally with a James Hutton, Esq. of Pimlico, Westminster, a near relation of Sir Isaac Newton, to whom he mentioned what he had heard from me with respect to Sir Isaac's descent, and that I wished much to know something more decisive on that subject. Mr Hutton said, if I pleased to write to him, he would give me all the information he could give. I wrote him accordingly, and had a very polite answer, dated at Bath, 25th December 1787, which is now before me. He says, " I shall be glad, when I return to London, if I can find in some old notes of my mother, any thing that may fix the certainty of Sir Isaac's descent. If he spoke so to Mr James Gregory, it is most certain he spoke truth. But Sir Isaac's grandfather, not his great-grandfather, must be the person who came from Scotland with King James I. If I find any thing to the purpose, I will take care it shall reach you."

In consequence of this letter, I expected another from Mr Hutton when he should return to London, but have never had any. Mr Wilson told me he was a very old man, and whether he be dead or alive I know not.

This is all I know of the matter, and for the facts above mentioned, I pledge my veracity. I am much obliged to you, Dear Sir, for the kind expressions of your affection and esteem, which, I assure you, are mutual on my part, and I sincerely *sympathise with you* on your afflicting state of health, which makes you consider yourself as out of the world, and despair of seeing me any more.

I have been long out of the world by deafness and extreme old age. I hope, however, if we should not meet again in this world, that we shall meet and renew our acquaintance in another. In the mean time, I am, with great esteem, Dear Sir, yours affectionately, **Tho. Reid.**

Glasgow College,
12th April 1792.

Art. XIV.—*Remarks on the Comparative Number of the Sexes at Birth.* By M. Hufeland of Berlin.

THE celebrated M. Hufeland of Berlin has inserted in his Journal of Practical Medicine, some observations in illustration of the comparative numbers of the sexes at birth, which possess considerable interest.

Dr Arbuthnot, physician to Queen Anne, first (*Phil. Trans*, Vol. xxvii.) pointed out, from the bills of mortality of London, that the number of males born exceeded that of females. This was confirmed by Gravesende, and the proportion was determined by the laborious Süssmilch, from an immense mass of documents, to be 21 males to 20 females. It was however doubted if this law was universal; and, in particular, Bruce and Niebuhr contended, that in countries where polygamy is tolerated, the females exceed the males; and Forster even went so far as to assert, that this excess of the females was owing to the feebleness of the men. But this effect is denied by Hufeland, from his own observations. One man in the prime of life begot only daughters, and after he was old and debilitated, sons. Porter, the English Ambassador at the Porte, denied (*Phil. Trans.* Vol. xlix.) the excess of female births in Turkey, and found that polygamy did not favour population, as the children commonly did not exceed from three to six in polygamous families. In China, the numbers are said to be equal (*Lettres edifiantes et curieuses*, Recueil 26.) In Tranquebar, an accurate record was kept for seventeen years by the missionaries, from which it appeared, that among the Europeans there, 156 boys and 141 girls were born: and among the natives, 914 boys and 857 girls. In Calcutta, a four years register gave 1290 boys, and 1240 girls, almost entirely from Tamul parents. In Batavia in 1748, among the Chinese, there were under fourteen years of age 1063 boys and 896 girls; among the Malays, 203 boys and 201 girls; among the Macassers, 691 boys and 599 girls; among the Javanese, 3949 boys and 3860 girls: In all, 34,000 boys and 28,000 girls (Valentyn, *Beschryving van Amboyna.)* Humboldt found, that in New Spain the proportion was as 100 to 97, whereas in France it is 100 to 96 only. Hufeland thought it interesting to ascertain the proportion among the Jews, as a remarkable remnant of an Oriental and Patriarchal People; and he found that of 893 successive births in Berlin, during sixteen years, 528 were boys and 365 girls, a proportion almost as high as 28 to 20. But upon the whole, the number of males born to that of females, seems to be 21 to 20 over the whole earth. The proportion of the sexes is reduced to perfect equality before they reach the age of puberty, as more boys than girls die before fourteen.

By the assistance of Link, and especially of Rudolphi, Hufeland has extended the comparison over animated nature in general. In hermaphrodite flowers, all proportions between the sexes are found, but monogamy is very rare, and the excess of the male sex, (or more stamina than pistils), very great. Diœcious plants are more analogous to animals, and here the male sex predominates, as may be observed in a field of hemp, or in the willow and poplar tribes.

Worms are generally hermaphrodite, but there are two kinds of intestinal worms where the sexes are distinct, and in these the predominance of the female is immense. Indeed, of one, the *oxyuris*, no male has been detected. In insects in general the male predominates, but the working bees and amazon ants are undeveloped females. In fishes, Bloch says the males are most numerous; but Staunton, in his voyage to China, states that the seal fishers reckon 30 females to one male. Of the amphibia little is known; but according to Rudolphi, the male is much less frequent among the *Lacerta agilis* than the female. In birds, the female decidedly predominates. In the mammalia, polygamy is most frequent, and one male is sufficient for thirty or forty females. Upon the whole, it appears that the female sex is most numerous among animals, except the human race.

Professor Hufeland then proceeds to an inquiry peculiar to himself, in endeavouring to ascertain the principles and commencement of the equality of the sexes. In some families it evidently does not hold. In some the children are all boys, in others all girls. He next took several families, as 20, 30, 40, or 50 in one place, in conjunction; or small villages of 150 to 300 inhabitants. But even then the just proportion was not yet established. In some years only boys, in others only girls, were born; nay, this disproportion continued sometimes for a series of a year or two, but by uniting ten or fifteen years together, the regular equality appeared.

He next considered that what took place in ten years in small populations, must take place every year in larger societies, and he accordingly found it confirmed by actual enumeration. He went so far as, by the aid of the Minister of State, Schuckmann, to ascertain the comparative number of boys and girls born in one day over the whole Prussian dominions, and the result corresponded with his anticipations.

On the 1st August 1815, there were born in

Province.	City.	Boys.	Girls.	Province.	City.	Boys.	Girls.
Prussia,	Konigsberg,	39	21	Saxony,	Merseburg,	24	37
	Gumbinnen,	21	21		Magdeburg,	36	24
West Prussia,	Dantzic,	18	12		Erfurth,	12	10
	Marienwerder,	17	23	Westphalia,	Munster,	15	15
Brandenburg,	Berlin,	7	10		Minden,	24	17
	Potsdam,	30	19		Arnsburg,	20	21
	Frankfort,	33	29	Berg,	Cologne,	24	20
Pomerania,	Stetin,	7	14		Dusseldorf,	15	16
	Coslin,	17	8		Cleves,	11	13
Silesia,	Breslaw,	25	31	Lower Rhine,	Coblentz,	18	20
	Reichenbach,	16	20		Aachen,	16	14
	Liegnitz,	24	34		Treves,	15	13
	Oppeln,	38	35				
Posen,	Posen,	43	39		Total,	587	55
	Bromberg,	21	20	Or 21.115 Boys to 20 Girls.			

The general conclusions are, that

1. There is an equal number of males and females born in the human race.

2. The equality occurs every day in a population of 10 millions.

3. Every week in 100,000.

4. Every month in 50,000.

5. Every year in 10,000.

6. And in small societies of several families, every ten or fifteen years.

7. That it does not occur in individual families.

ART. XV.—*History of Chemical Discoveries.*

IN a Journal of General Science, which necessarily embraces the various departments of abstract and practical knowledge, it cannot be expected that a disproportionate number of its pages should be devoted to any of the individual sciences. The great practical utility of general Chemistry, and the small expence of thought and of previous education, with which it can be pursuéd, have rendered it popular among a class of readers who shrink without reason from what they think the more severe researches of physical science. In order to gratify, as far as we can, this respectable class of our readers, we have resolved to occupy a portion of each number with an abbreviated account of Chemical Discoveries and the results of chemical investigations; and in those cases where we could not be expected to enter into details, we shall enable the reader to pursue his own inquiries, by references to those works, and to the foreign and domestic Journals, in which interesting chemical papers have appeared.

I. *On the Conversion of Animal Matter into new Substances by the Sulphuric Acid.* By H. Braconnot.

After having ascertained (See this Journal, vol. ii. p. 363) that all ligneous matter, such as wood, bark, straw, hemp, &c. may be transformed into gum, and into sugar, by the sulphuric acid, M. Braconnot extended his researches to the parts of animals, and he began with gelatine, as obtained from the skin, membranes, tendons, &c. of animals.

1. He found that gelatine may be converted by sulphuric acid into a crystallisable sugar *sui generis*, which probably does not exist in nature. It crystallises more readily than that from the cane. It is less fusible, and it contains azote. Its sweetness is nearly equal to that of the sugar of grapes. Its solubility in water is not greater than that of sugar of milk, with which it has at first sight some analogies. By slow evaporation, it yields crystals as hard as sugar-candy, and in the form of flat prisms or tables grouped together.

2. That the sugar of gelatine combines intimately with the nitric acid, with sensible decomposition, and even without the aid

of heat, and then forms a *new acid*, to which he has given the name of the *nitro-saccharic*. This acid is very soluble, and crystallises with great facility in fine colourless prisms, transparent, flat, and striated like those of sulphate of soda. Its taste is acid; it is slightly saccharine, and very like tartaric acid. It produces no change in metallic or earthy solutions. United to potash, it forms a super-salt and a neutral salt, both of which crystallise in fine needles, which have a sort of nitrous taste. It detonates like nitre on burning coals. The new acid dissolves carbonate of lime with a strong effervescence, and the solution yields fine prismatic needles. This salt does not attract humidity, and is scarcely soluble in concentrated alcohol. Thrown on burning coals, it melts in its water of crystallisation, and then detonates like nitre. With oxide of copper, the *nitro-saccharic acid* forms a crystallisable salt unalterable in the air;—with magnesia a deliquescent uncrystallisable salt; and with oxide of lead an uncrystallisable salt, unalterable in the air, and resembling gum. It dissolves iron and zinc, with the disengagement of hydrogen gas, the results of which are uncrystallisable combinations.

3. That *wool*, and particularly the muscular fibre *(fibrine,)* when treated with sulphuric acid, yield a particular white pulverulent substance, which he has called *Leucine.* When a solution of leucine, in lukewarm water, is evaporated spontaneously, a number of small isolated crystals are formed at its surface. They are flat, perfectly circular, and have exactly the shape of the moulds of buttons, with a rim round their circumference, and a point or a depression in their centre. Leucine has the taste of the juice of meat. It appears to be specifically lighter than water. It melts at a temperature considerably above that of boiling water, and spreads an odour of putrid meat, subliming partly in the form of small white insulated crystals. Leucine dissolves easily in nitric acid, and produces fine colourless and divergent needle crystals, which are a *new acid, analogous to the nitro-saccharic.* This *nitro-leucic* acid forms, with salifiab [illegible] alts which have quite a different arrangement from th [illegible] *rates.* Combined with lime it yields a salt, which [illegible] small rounded groupes, and is unalterable in th [illegible] on a burning coal, it fuses

less rapidly than the *nitro-saccharate of lime.* With magnesia it also gives a salt in small crystalline grains, which does not attract humidity like the *nitro-saccharate of magnesia.*

4. That other uncrystallisable and sapid substances, analogous to certain vegetable principles, are produced by the reaction of the sulphuric acid on the most insoluble animal substances.—Abridged from the *Ann. de Chim.* tom. XIII. p. 113.

II. *On the Caloric of a Vacuum.* By M. GAY LUSSAC.

In order to prove by an experiment on a large scale, that a thermometer placed *in vacuo* indicates no variation of temperature when the vacuum is suddenly diminished or enlarged, M. Gay Lussac employed a barometer 75 millimeters in diameter, and nearly a metre long. It was a tube of glass shut up at its upper extremity by a plate of metal perforated with two holes, one for admitting an air thermometer into the barometric vacuum, and the other for establishing, by means of a very narrow tube, with a stop-cock, a communication between the large tube and a good air-pump, for making the vacuum. This tube, when filled with mercury, had a considerable weight, and was fixed between two pillars by means of a large collar carrying two gudgeons, upon which it was supported. The cistern in which its lower end was plunged, was about five decimetres deep. It was suspended by two cords, coiled round a barrel with a winch, and by raising or depressing it, the extent of the barometric vacuum could be varied at pleasure. The ball of the air thermometer was placed in the upper part of the tube, near the metallic plate already mentioned. It was nearly of the same diameter as the interior of the tube; and the stem of the thermometer, in which there was a small column of coloured water, was, on the contrary, of a very small diameter. The sensibility of this instrument was very great, and the calculation of its dimensions showed, that the *six hundredth part of a degree* occupied nearly a millimetre upon the scale, and was therefore very appreciable.

Having made as perfect a vacuum as possible, the cistern was raised till the column of mercury reached the top of the tube, and even rose very near the stop-cock. Upon shutting the stop-cock, and making the cistern descend, a vacuum is obtained nearly as perfect as the Torricellian one, because the mercury was carefully dried, and some pieces of chlorure of calcium introduced into the tube, to absorb the humidity. When it was required to augment the vacuum, the extremity of the mercurial column was brought near the ball of the thermometer, and when the temperature was seen to be permanent, the cistern was rapidly brought down, in the third of a second, and in order to diminish the vacuum, the cistern was raised by turning the winch. But though the vacuum was reduced from about a litre to one-fourth of its volume, or *vice versa*, the *air-thermometer never indicated the slightest variation.* As soon, however, as a small quantity of air was introduced, very sensible variations of temperature took place, by compressing or dilating the barometrical space. Hence we may conclude, that a vacuum does not contain caloric like bodies in general. It is only therefore caloric in motion which exists in a vacuum, during the short time that it takes to pass through it in the form of radiant heat.—Abridged from the *Ann. de Chim.* tom. XIII. p. 304.

III. *Observations on Oily Substances.* By M. THEODORE DE SAUSSURE.

As our limits will not permit us to give a detailed account of this interesting paper, we must confine ourselves to a general view of the results obtained by its able author; referring for the paper itself to the *Bibliotheque Universelle*, Jan. 1820, p. 20—42. and Feb. 1820, p. 112—135.

Substances Examined.	Carbon.	Hydrogen.	Oxygen.	Azot.	Original Density.	Density when distilled.
Essence of lemons,	86.899	12.326	—	0.775	0.8517	0.847 at 22°
—— turpentine,	87.788	11.646	—	0.566	—	0.86 cent.
—— lavender,	75.5	11.07	13.07	0.36	0.898	0.877 at 20°.
—— camphor,	74.38	10.67	14.61	0.34	—	0,988
—— rosemary	82.21	9.42	7.73	0.64	0.9109 at 15°	0.8886
—— anise, common,	76.48	9.352	13.821	0.34	—	0.9857 at 25°
—— concrete,	83.468	7.531	8.541	0.46	—	0.9849
—— roses, common,	82.053	13.124	3.949	0.877	—	0.832
—— concrete,	[illegible]	[illegible]	—	—		—
Purified bees' wax,	[illegible]	[illegible]	[illegible]	—	0.966 when fixed.	0.834 at 81°
	[illegible]	[illegible]	[illegible]	0.354	—	—
Margaric acid,	[illegible]	[illegible]	[illegible]	—	1.01 solid.	0.854 at 94°

Substances Examined	Carbon.	Hydrogen.	Oxygen.	Azot.	Original Density.	Density when distilled.
Crystals of biliary calculi,	84.068	12.018	3.914	—	Heavier than water.	
Purified fat of pork,	78.843	12.182	8.502	0.473	—	0.8918 at 50°
Elaine,	74.792	11.652	13.556	—	—	—
Elaine olive oil,	76.034	11.545	12.068	0.353	—	0.915 at 15°
Stearine oil of olive,	82.17	11.232	16.302	0.296	—	0.968 at 15°
Nut oil,	79.774	10.570	9.122	0.534	—	—
Oil of sweet almonds,	77.403	11.481	10.828	0.288	—	—
Linseed oil,	76.014	11.351	12.635	—	—	—
Castor oil,	74.148	11.034	14.788	—	—	—

Combustion of different Oils reduced each to the Weight of a Gramme.

Oils.	Oxygen gas consumed.	Carbonic acid gas produced.	Azotic gas in the ammonia.	Ratio of the oxygen gas to the carbonic acid gas.
Nut oil,	1.9778 litre.	1.4833 lit.	12.63 centimes	100 to 75.00
Oil of sweet almonds,	1.9699	1.439	6.571	100 to 73.06
Linseed oil,	1.9247	1.4134	—	100 to 73.44
Castor oil,	1.8586	1.3792	a trace.	100 to 74.20

Dilatations or Densities at different Temperatures relatively to Water = 1 at 15° Centigrade.

Degrees of the Centigrade Thermometer.	12°	25°	50°	94°
Nut oil,	0.9283	0.9194	—	0.8710
Oil of almonds,	0.9201	—	—	0.8632
Linseed oil,	0.9395	0.9300	0.9125	0.8815
Castor oil,	0.9699	0.9575	—	0.9081
Oil of olives,	0.9192	0.9109	0.8932	0.8625
Concrete oil of anise,	—	0.9849	—	0.9256
Essence of rhubarb,	0.8901	0.8805	0,8604	0.8208
Rectified naphtha of Amiano,	0.7688	0.7574	0,7337	—

IV. *Account of Brucine, a New Vegetable Alkali.*

This new alkali was obtained by MM. Pelletier and Caventou from the *Brucea antidysenterica.* A kilogramme, or 32 oz. troy, having been reduced to powder, was digested in sulphuric ether, to separate a fatty matter which it contains. The ether being withdrawn, it was heated with alcohol in successive portions, and when the different infusions were added together, the alcohol was evaporated. The residue was then dissolved in water, sub-acetate of lead was added, which precipitated the greater part of the colouring matter, and the excess of lead was separated from the solution by sulphuretted hydrogen. The brucine contained in this solution was saturated with oxalic acid, which formed a salt very little soluble in alcohol, and it was then well washed in alcohol, till the salt was colourless. The oxalate being decomposed by lime or magnesia, the brucine was liberated, and being next dissolved in boiling alcohol, it was crystallised by spontaneous evaporation. The crystals of brucine are oblique prisms, with parallelograms for their bases. They are colourless and transparent, and are sometimes several lines long. Brucine dissolves in 500 parts of boiling water, and 850 parts of cold water. It has an exceeding bitter acrid taste, and when administered in doses of a few grains, it is poisonous, though it acts only with one-twelfth of the energy of *strychnine*. It undergoes no change in the air, melts at a temperature a little greater than that of boiling water, without decomposition, and resembles wax when cooled. When strongly heated, it is decomposed, and yields much empyreumatic oil, a little water, acetic acid, carburetted hydrogen, and a very little carbonic acid. When decomposed by oxide of copper, it yields much carbonic acid, and water, and a little nitrogen, which seemed accidental. No trace of ammonia could be discovered among the products.

Sulphate of Brucine crystallises in long slender needles, which seem to be four-sided prisms, terminated by pyramids. It is very soluble in water, and slightly so in alcohol. It is very bitter. It is decomposed by potash, soda, ammonia, barytes, strontia, lime, and magnesia, and also by morphium and strychnine, which dissolve in it readily. It does not dissolve in any of the acids but the nitric, which alters the brucine itself, and as with strychnine and morphium, produces a fine red colour. When an excess of acid is added to the solution of this salt, it crystallises more readily, and the crystals are larger, and retain the excess of acid after repeated solutions and crystallisations. The neutral sulphate contains

Sulphuric acid, -	8.84	9.697
Brucine, -	91.16	100.000

Muriate of Brucine crystallises in four-sided prisms, terminated with an inclined face. It is very soluble in water, and is not altered by the air. When heated to a certain degree, it is decomposed, and the muriatic acid goes off in white vapours. It is decomposed by sulphuric acid and those bases which decompose the sulphate. It consists of

Muriatic acid, -	5.9533	6.331
Brucine, -	94.0467	100.000

Phosphate of Brucine does not crystallise unless it contains an excess of acid, and it then yields large rectangular tables, with bevelled edges. This salt is very soluble in water. It effervesces slightly in the air, and is soluble in strong alcohol at common temperatures.

Nitrate of Brucine. The neutral salt forms only a gummy mass by evaporation. The super-salt crystallises readily in acicular quadrangular prisms, with dihedral summits, and inflames and burns when sufficiently heated. If nitric acid is added in excess, a fine red colour is produced, probably from a peroxygenation of the alkali. When the liquid is heated, it becomes yellow; and when proto-muriate of tin is added to the yellow liquor, it produces an intense and beautiful purple.

Acetate of Brucine is soluble, but does not crystallise.

Oxalate of Brucine crystallises readily in long needles, particularly if the acid is in excess.

Brucine is very soluble in alcohol, insoluble in sulphuric ether and the fat oils, and very little soluble in the essential oils.

When administered internally, it produces tetanus, and acts on the nerves without attacking the brain, or affecting the intellectual faculties. Four grains were necessary to kill a rabbit; and a dog that took three grains, suffered severely, but recovered.—See the *Ann. de Chim.* XVI. p. 113.

V. *Account of Delphine, a New Vegetable Alkali.*

This alkali was discovered in 1819 by MM. LASSAIGNE and FENEUELLE * in the seeds of *stavesacre (Delphinium staphysagria)* where it exists in union with malic acid. When the seeds are deprived of their husks and rinds, they are boiled in a small quantity of distilled water, then pressed in a cloth, and the decoction filtered and boiled for a few minutes with pure magnesia. It must then be refiltered, and the residuum left in the filter. After being well washed, it is boiled with highly rectified alcohol, which dissolves the alkali, and by evaporation it is obtained as a white pulverulent substance, presenting a few crystalline points.

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* Dr Brandes is said to have discovered Delphine before the French chemists.—ED.

Pure delphine is crystalline while wet; but becomes rapidly opaque when exposed to the air. It has a bitter acrid taste, melts by heat, and becomes hard and brittle like resin when cooled. By a greater degree of heat it blackens, and is decomposed. Water dissolves a very small portion of it. Alcohol and ether dissolve it readily. The alcoholic solution renders syrup of violets green, and restores the blue tint of litmus reddened by an acid. It forms very soluble neutral salts with the acids. The alkalies precipitate it in a white gelatinous state like alum.

Sulphate of Delphine does not crystallise, but by spontaneous evaporation dries into a hard transparent mass like gum. It has a bitter acrid taste, which continues many hours, and dissolves readily in water and alcohol. When the galvanic current is passed through a concentrated solution of it, the sulphuric acid is deposited at the positive pole, and the delphine at the negative pole, in white flocks.

Nitrate of Delphine, formed by dissolving the delphine in weak nitric acid, is colourless. It assumes a yellow colour by concentration; and retains that colour, and has a crystalline appearance when evaporated to dryness. When heated with an excess of acid, it is converted into a yellow matter, little soluble in water, and difficultly soluble in boiling alcohol. This solution is bitter, and is not precipitated by potash, ammonia, or lime-water. Though not alkaline, it appears not to contain any nitric acid. It was not altered by farther quantities of acid, and no trace of oxalic acid ever appeared.

Acetate of Delphine does not crystallise, but is converted by drying into a hard transparent mass, which has a bitter and acrid taste, and is readily decomposed by cold sulphuric acid.

Oxalate of Delphine crystallises in white plates, and possesses the same taste as the other salts of delphine.

When delphine is calcined with peroxide of copper, it gives out no other gas but carbonic acid.—See the *Ann. de Chim.* xii. 358.

VI. *New Vegetable Principle in Elaterium.*

Dr Paris has discovered in the plant *Momordica elaterium* a new vegetable principle, which acts more violently upon the human body than arsenic. It is lodged only in the juice round the seeds, and exists in such a small quantity, that Dr Clutterbuck obtained only 6 grains from 40 cucumbers; and even of this fecula, although the eighth part of a grain will purge violently, yet not more than one-tenth of that virulent substance possesses any active virtues. To this active principle he gives the name of *Elatine*. The following, according to Dr Paris, is the composition of elaterium:

Water, - -	4
Extractive, -	26
Fecula, - -	28
Gluten, - -	5
Woody matter, -	25
Elatine - *Bitter Principle*,	12
	100

The bitter principle in elaterium is very distinct from its extractive matter. The solution of the elatine and bitter principle being diluted, and swallowed, produced only an increase of appetite, while the solution of the extractive matter produced no effect whatever.—See the *Phil. Mag.* May 1820, vol. LV. p. 390.

VII. *Observations on the Red Snow of Mount St Bernard.*

Some imperfect observations on the red snow of the Alps were made by M. Saussure in 1778, and the result of them appeared in the 3d volume of his Travels. M. Peschier of Geneva has recently investigated this subject with much attention and success. The red snow has been found on Mount St Bernard, the Col de la Seigne, and the Bonhomme, and is generally at the same altitude as these summits on the other parts of the Glaciers. It is more abundant after high S. or S. W. winds. It is found to the depth of two or three inches, and most commonly occurs where the snow longest resists dissolution, at the bottom of declivities covered with snow, because the red substances are carried and deposited there by the currents.

From four residues of the red snow, M. Peschier obtained the following results:

No. I.	
Siliceous substance, -	65.50
Alumina, - -	6.35
Peroxide of iron, -	21.35
Soluble organic substance,	6.80
	100.00

No. II.	
Insoluble substance, -	20.00
Alumina, - -	4.25
Peroxide of iron, -	31.25
Chalk, - - -	0.50
Insoluble organic substance,	37.50
Soluble organic substance,	6.50
	100.00

No. III.	
Siliceous substance, -	14.18
Peroxide of iron, -	3.25
Alumina, - -	1.75
Chalk, - -	0.10
Resinous principle, -	3.20
Organic ditto. - -	2.25
Soluble ditto, -	1.75
	26.48

No. IV.	
Silex, - -	1.25
Peroxide of iron, -	12.34
Chalk, - -	0.20
Organic substance and water,	10.00
	23.79

From these analysis M. Peschier concludes, that the red colour arises from two different causes, viz. 1. From a greater or less quantity of the oxide of iron spread over its surface, in a state of minute division, of a high degree of oxidation. 2. From a resinous vegetable principle, of an orange-red colour, belonging apparently to some alga or lichen. As there are many vegetables containing iron, he considers it not improbable, that this iron may form one of the immediate principles of the vegetables in question, of which only the fragments are found, and that, in conjunction with the resinous principle, it is the direct cause of the red colour. See *Bibliotheque Universelle*, Dec. 1819; and *Ann. of Phil.* xc., p. 406.

VIII. *Experiments on the Alloys of Steel.* By J. STODART, Esq. and M. FARADAY, Esq.

A very interesting paper on the alloys of steel, by our ingenious countryman Mr Stodart, and by Mr M. Faraday, has appeared in the last number of the Journal of Science, (N° xviii. p. 319.)

The metals which were used were *Platinum*, *Rhodium*, *Gold*, *Silver*, *Nickel*, *Copper* and *Tin*, all of which were alloyed in various proportions with both *English* and *Indian Steel*. All these metals have a sufficiently strong affinity to steel, to make them combine. The *platina* fuses when in contact with the steel at a temperature at which the *steel* itself is not affected.

1. *Steel and Silver.*—" If steel and silver be kept in fusion together for a length of time, an alloy is obtained, which appears to be very perfect while the metals are in the fluid state, but on solidifying and cooling, globules of pure silver are expressed from the mass, and appear on the surface of the button. If an alloy of this kind be forged into a bar, and then dissected by the action of dilute sulphuric acid, the silver appears, not in combination with the steel, but in threads throughout the mass; so that the whole has the appearance of a bundle of fibres of silver and steel, as if they had been united by welding. The appearance of these silver fibres is very beautiful; they are sometimes $\frac{1}{8}$th of an inch in length, and suggested the idea of giving mechanical toughness to steel, where a very perfect edge may not be required.

When silver and steel have been very long in a state of perfect fusion, the sides of the crucible, and frequently the top also, are covered with a fine and beautiful dew of minute globules of silver; this effect can be produced at pleasure. At first we were not successful in detecting silver by chemical tests in these buttons; and finding the steel uniformly improved, were disposed to attribute its excellence to an effect of the silver, or to a quantity too small to be tested. By subsequent experiments we were, however, able to detect the silver, even to less than 1 in 500.

In making the silver alloys, the proportion first tried was 1 silver to 160 steel; the resulting buttons were uniformly steel and silver in fibres, the silver being likewise given out in globules during solidifying, and adhering to the surface of the fused button; some of these when forged gave out more globules of silver. In this state of mechanical mixture, the little bars, when exposed to a moist atmosphere, evidently produced voltaic action, and to this we are disposed to attribute the rapid destruction of the metal by oxidation, no such destructive action taking place when the two metals are chemically combined. These results indicated the necessity of diminishing the quantity of silver; and 1 silver to 200 steel was tried. Here, again, were fibres and globules in abundance; with 1 to 300, the fibres diminished, but still were present; they were detected even when the proportion of 1 to 400 was used. The successful experiment remains to be mentioned. When 1 of silver to 500 steel were properly fused, a very perfect button was produced; no silver appeared on its surface; when forged and dissected by an acid, no fibres were seen, although examined by a high magnifying power. The specimen forged remarkably well, although very hard; it had in every respect the most favourable appearance. By a delicate test every part of the bar gave silver. This alloy is decidedly superior to the very best steel, and this excellence is unquestionably owing to combination with a minute portion of silver. It has been repeatedly made, and always with equal success. Various cutting tools have been made from it of the best quality. This alloy is perhaps only inferior to that of steel with rhodium, and it may be procured at a small expence; the value of silver, where the proportion is so small, is not worth naming; it will probably be applied to many important purposes in the arts. An attempt was made to procure the alloy of steel with silver by cementation; a small piece of steel wrapped in silver leaf, being 1 to 160, was put into a crucible, which being filled up with pounded green glass, was submitted to a heat sufficient to fuse the silver; it was kept at a white heat for three hours. On examining it, the silver was found fused, and adhering to the steel; no part had combined. The steel had suffered by being so long kept at a high temperature. Although this experiment failed in effecting the alloy of steel with silver, there is reason to believe that with some other metals, alloys may be obtained by this process; the following circumstance favours this suggestion. Wires of platinum and steel, of about equal diameter, were packed together, and, by an expert workman, were perfectly united by welding. This was effected with the same facility as could have been done with steel and iron. On being forged, the surface polished, and the steel slightly acted on by an acid, a very novel and beautiful surface appeared, the steel and platinum forming dark and white clouds; if this can be effected with very fine wires, a damasked surface will be obtained, of exquisite beauty. This experiment, made to ascertain the welding property of platinum, is only mentioned here in consequence of observing that some of the largest of the steel clouds had much the appearance of being alloyed with a portion of the platinum. A more correct survey of the surface, by a high magnifying power, went far to confirm this curious fact; some more direct experiments are proposed to be made on this apparent alloy by cementation.

2. *Steel and Platinum.*—The alloys of steel with platinum, when both are in a state of fusion, are very perfect, in every proportion that has been tried. Equal parts by weight form a beautiful alloy, which takes a fine polish, and does not tarnish; the colour is the finest imaginable for a mirror. The specific gravity of this beautiful compound is 9.862.

90 of platinum with 20 of steel, gave also a perfect alloy, which has no disposition to tarnish, the specific gravity 15.88; both these buttons are malleable, but have not yet been applied to any specific purpose.

10 of platinum to 80 of steel, form an excellent alloy. This was ground and very highly polished to be tried as a mirror; a fine damask, however, renders it quite unfit for that purpose.

The proportions of platinum that appear to improve steel for edge instruments, are from 1 to 3 *per cent.* Experience does not yet enable us to state the exact proportion that forms the best possible alloy of these metals; 1.5 *per cent.* will probably be very nearly the best. At the time of combining, 10 of platinum with 80 steel, with a view to a mirror, the same proportions were tried with nickel and steel; this too had the damask, and consequently was unfit for its intention. It is curious to observe the difference between these two alloys, as to susceptibility for oxygen. The platinum and steel, after lying many months, had not a spot on its surface, while that with nickel was covered with rust; they were in every respect left under similar circumstances.

3. *Steel with Rhodium.*—The alloys of steel with rhodium are likely to prove highly valuable. The scarcity of this metal must, however, operate against its introduction to any great extent. The proportions we have used are from 1 to 2 *per cent.*

The valuable properties of the rhodium alloys are hardness, with sufficient tenacity to prevent cracking either in forging or in hardening. This superior hardness is so remarkable, that in tempering a few cutting articles made from the alloy, they required to be heated full 30° F. higher than the best wootz, wootz itself requiring to be heated full 40° above the best English cast steel.

4. *Steel with Gold.*—Gold forms a good alloy with steel. Experience does not yet enable us to speak of its properties. It certainly does not promise to be of the same value as the alloys of silver, platinum and rhodium.

5. *Steel with Copper and with Tin.*—Steel with 2 *per cent.* of copper, forms an alloy. Steel also alloys with tin. Of the value of these we have doubts."

Table of Specific Gravities of Alloys, &c., mentioned in the preceding Paper.

Iron, unhammered,	7.847
Wootz, unhammered, (Bombay)	7.665
Wootz, tilted, (Bombay)	7.6707
Wootz, in cake, (Bengal)	7.730
Wootz, fused and hammered, (Bengal)	7.787
Meteoric iron, hammered,	7.965
Iron, and 3 *per cent.* nickel,	7.804
Iron, and 10 *per cent.* nickel.	7.849
Steel, and 10 *per cent.* platinum, (mirror)	8.100
Steel, and 10 *per cent.* nickel, (mirror)	7.684
Steel, and 1 *per cent.* gold, hammered,	7.870
Steel, and 2 *per cent.* silver, hammered,	7.808
Steel, and 1.5 *per cent.* platinum, hammered,	7.732
Steel, and 1.5 *per cent.* rhodium, hammered,	7.795
Steel, and 3 *per cent.* nickel, hammered,	7.750
Platinum 50, and steel 50, unhammered *,	9.862
Platinum 90, and steel 20, unhammered †,	15.88
Platinum hammered and rolled,	21.25

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* The calculated mean specific gravity of this alloy is 11.2723 assuming the specific gravity of platinum and steel, as expressed in this Table.

† The calculated mean specific gravity of this alloy is 16.0766.

IX. *Chemical Analyses.*

1. *Pyro-Uric Acid.*—MM. Chevalier and Lassaigne found that this acid, in a state of purity, consisted of

		Volumes.
Oxygen, -	44.32	7
Carbon, -	28.29	12
Azote, -	16.89	3
Hydrogen,	10.00	25½
	99.45	

2. *Pyro-Urate of Lime* consists of

Pyro-uric acid,	91.4
Lime, -	8.6

3. *Subpyro-Urate of Lead* consists of

Pyro-uric acid,	28.5
Oxide of lead,	71.5

See *Journ. de Pharm.* vi. 58.

4. *Combinations of Iron and Sulphur.*—The following table of the combinations of iron and sulphur has been given by Mr Porret:

1. *Cubic Pyrites,*	1 atom iron,	1.75
	1 atom sulphur,	2.00
2. *Magnetic Pyrites,*	2 atoms iron,	3.5
	1 atom sulphur,	2.0
3. *Sesquisulphuret,*	3 atoms iron,	5.25
	2 atoms sulphur,	4.0
4. *Tritosulphuret,*	4 atoms iron,	7.0
	3 atoms sulphur,	6.0

5. *Octohedral Iron-Ore.*

Protoxide of iron,	94
Oxide of titanium,	6

Robiquet, *Journ. de Pharm.* v. 258.

6. *Sulphuric Acid,* according to Berzelius, consists of

Sulphur, -	100.00
Oxygen, -	148.44

7. *Ferrochyazic Acid,* according to Dr Thomson, is composed of

2 atoms carbon,	1.500
1 atom hydrogen,	0.125
1 atom azote, -	1.750
½ atom iron, -	1.750
	5.125

8. *Subcarbonate of Ammonia*, according to Mr R. Phillips, is composed of

3 atoms carbonic acid,	55,933
2 ditto ammonia,	28.813
2 ditto water,	15.254
	100.000

9. The *Bi-carbonate* formed by exposing this salt to the air, consists of

2 atoms carbonic acid,	55.80
1 ditto ammonia,	21.16
2 ditto water,	23.04
	100.00

Quarterly Journal, vol. v.

10. *Muriate of Gold and Soda.*—When gold is dissolved in aqua-regia, and the solution made as neutral as possible by evaporating to the consistence of a syrup, it is then diluted with water, and mixed with a solution of common salt. By concentration thin rectangular parallelopipeds are obtained, which consist of

Muriatic acid,	19.75
Oxide of gold,	50.76
Soda,	8.50
Water,	20.99
	100.00

Journ. de Pharm. vi. 64.

11. *Sulphate of Nickel*, according to Berthier, consists of

Sulphuric acid,	52.2
Oxide of nickel,	47.8

12. *Carbonate of Nickel* consists of

Carbonic acid,	14.0
Oxide of nickel,	47.5
Water,	38.5

13. *Oxymuriate of Lime, or the common bleaching powder*, according to Dr Thomson, consists of

Subbichloride of lime,	36.52
Muriate of lime,	18.50
Water,	16.93
Uncombined lime, &c.	28.05
	100.00

14. *Globular or Oolitic Carbonate of Iron*, according to Berthier, *Ann. des Mines*, consists of

Carbonate of iron,	81.2
Carbonate of magnesia,	5.8
Water,	2.0
Clay,	11.0

15. *Euclase*, according to Berzelius, *Ann. de Chim.* xi. p. 216, consists of

Silica,	43.22
Alumine,	30.55
Glucine,	21.78
Oxide of Iron,	2.22
Oxide of Tin,	0.70
	98.47

16. *Wavellite*, according to Berzelius and Fuchs, see *Ann. de Chim.* xii. p. 16. consists of

	Berzelius.	*Fuchs.*
Silica,	35.35	37.20
Phosphoric Acid,	33.40	35.12
Fluoric Acid,	2.06	...
Lime,	0.50	...
Oxides of Iron and Manganese,	1.25	...
Water,	26.80	28.00
	99.36	100.32

17. *Lasionite* has been found by M. Fuchs to have the same composition as Wavellite.

X. *On the existence of Cantharidin in the Lytta vittata, or Potato Fly.*

By J. F. Dana, M. D.

A peculiar substance called *Cantharidin* was found by Robiquet in the *Meloë vesicatorius*, and is supposed to be the peculiar matter which produces vesication. The power of blistering is known to belong in an eminent degree to the *Lytta vittata*, or potato fly, so common in North America; and some American physicians have supposed that its vesicatory powers are even greater than those of the Spanish fly.

In order to ascertain if this fly contained cantharidin, Dr Dana, digested 110 grains of the potato fly for several days, and, after a series of operations, he obtained a number of minute crystalline plates, which, when washed in alcohol, and dried, were white and pearly. When placed on the tender skin between the fingers, they soon excited itching, and produced redness; but vesication did not take place, from the very minute quantity which was used.—See Silliman's *American Journal of Science*, vol. ii. p. 137.

XI. *Reference to Chemical Memoirs in Foreign Journals, &c.*

1. *Mémoire sur la Combinaison de l'Oxygène avec l'Eau; et sur les propriétés extraordinaires que possede l'Eau Oxygénée.* Par M. Thenard. Published in the Mémoires de l'Institut 1818, p. 385,—488.

2. *De la Magnésie, dans les Analyses Chimiques.* Par M. Longchamp.—*Ann. de Chim.* tom. xii. p. 255.

3. *Nouvelles Rechérches sur la Nature du Bleu de Prusse.* Par M. Robiquet —*Id.* p. 277.

4. *Determination experimentale du Zero absolu de la Chaleur, et du Calorique specifique des Gaz.* Par MM. Clement et Desormes.—*Journal de Physique*, tom. 89. p. 321, 428. and *Biblioth. Universelle*, vol. xiii. p. 95. and vol. xiv. p. 89.

5. *Sur un Appareil Electro-chimique propre à reconnoitre la presence des Metaux en dissolution dans un liquide.* Par J. Macaire.—*Biblioth. Univers.* tom. xiii. Avril 1820, p. 279.

6. *On Heat and Light, with remarks on the Economy of Burning Water as an object of Fuel.* By Mr Samuel Morey. —Silliman's *American Journal of Science*, vol. ii. p. 118. 122.

7. *Examen Chimique du Kermes vegetal,* (Coccus ilicis). Par J. L. Lassaigne.—*Journal de Pharmacie*, tom. v. p. 435.

8. *Extrait d'un Mémoire sur la Nature et la Purification de l'Acide Pyro-ligneux.* Par M. Colin.—*Ann. de Chim.* tom. xii. p. 205.

9. *Des Phenomenes que presentent quelques Metaux lorsqu'on les soumet à la coupellation, soit qu'ils soient seuls, ou alliés entre eux.* Par M. Chaudet.—*Ann. de Chim.* tom. xii. p. 342.

10. *Premier Mémoir sur la Dissolubilité des Sels dans l'Eau.* Par M. Gay Lussac.—*Ann. de Chim.* xii. p. 296.

11. *De la Constitution intime des Gaz, et de leur Capacité pour le Calorique.* Par M. J. Mollet.—*Journal de Physique*, Fev. 1820, p. 113.

Many other Chemical Memoirs, of great interest, have been already referred to in our Scientific Notices, and in other parts of this Journal.

cases equal, we divide each of them into ten equal parts; one soon learns to value those parts with *tolerable* accuracy, and each of them is expressed by a decimal fraction, whenever the hardness is to be designated in numbers. Thus the hardness of a mineral, midway in that respect between felspar and quartz, will be expressed by 6.5, and so for others.

68. *Employment of the Scale.*—When the hardness of a mineral is to be determined, we first of all select from the scale those two numbers between which it stands, in order to compare it with them. This may be done by trying the scale, from the top downwards, till we hit upon some member of it which may be scratched by the given mineral, but which does not scratch it. We then take that member, the next above it, and the given mineral; and, having chosen from each a fragment pretty similar in form, and, so far as possible, similar in structure to the other two, we rub all the fragments on *a very delicate file.* The smallest possible force must be applied in this operation; the sound and feel will enable us to judge at what distance, in respect of hardness, the given mineral stands from both the members of the scale. This experiment may be repeated and altered, till the result can be regarded as certain, and depended on for any use to be made of it afterwards. The hardness of the file is so far indifferent, as it is not *with* that instrument that the mineral is compared, but *by means of it*, with the other members of the scale. For the higher degrees, however, the file ought to be *as hard as possible.* Practice will convince any one of the sufficiency of this method *for the natural history of the mineral kingdom*, and the experience, on which it certainly rests, may be acquired very soon. It resembles an imperfect instrument, which gains in correctness by the dexterity of him who applies it.

69. *Lustre and Colour.*—It has struck us, as necessary to settle the varieties of lustre in a manner somewhat different from their previous mode of arrangement. We divide metallic lustre into *perfect* and *imperfect.* The first is found in native metals, tl [illegible] nd in uran-ore, tantalite, and others. In characterising [illegible] terms “*metallic*” and “*non-metallic*,” are intr [illegible] former includes only the complete

metallic lustre, the latter includes every remaining variety, even the incomplete metallic lustre. In adamantine lustre, we distinguish the *metal-like* and the *common.* The first is found in wolfram, in the dark varieties of red-silver and cinnabar, in different varieties of blende and white lead-spar; the second in diamond, in the bright-coloured varieties of red silver and cinnabar, and others. The mother-of-pearl lustre may be distinguished into *common* and *metal-like* mother-of-pearl lustre. The first is found in foliated zeolite, in kyanite; the second in yellow orpiment, in schillerspar, and others. The resinous and vitreous lustres require no farther subdivision. In colours, we have separated the metallic from the non-metallic: The first only is used in the present system of characters. As to those other designations, which have been altered, or more strictly limited to serve the purposes of this system, we imagine it will be shorter to explain them afterwards, than to exhibit them here under a general aspect.

II. *Of Individuals in the Mineral Kingdom; of Simple and Compound Minerals; of Homogeneity, Species, Genus, &c.*

1. *Erroneous ideas of Individuality.*—The idea of individuality in the mineral kingdom is one of those concerning which the greatest number of errors have been entertained. Karsten, Steffens, Link, and Bernhardi, have all submitted to the public incorrect notions upon this point. It is a subject of importance for the right understanding of some others (7. 8.) which are founded on it; and hence, in treating of natural history, to pass it over in silence would be unsatisfactory.

2. *Correct idea. Explanation by examples.*—Generally speaking, the name of Individual, in natural history, is given to any thing or substance which, by itself, is capable of becoming an object of contemplation in this department of science, and which, therefore, appears as a whole, or must be represented as a whole. In the mineral kindgom, any crystal of calcareous-spar, for example, is an individual; any grain of diamond or garnet, for example, is an individual; but a fragment, for instance, of granular limestone, is not so. The former are wholes, and by division cease to be wholes; the latter is not a

whole, and dividing or breaking it in pieces does not make it cease to be what it was.

3. *Reason of the mistake.*—Misled by the false idea of distinct concretions, mineralogists have considered the fragment of granular limestone as *a fragment of an individual.* They have sought this individual *on the great scale*, and taken for it the bed or mountain-mass, from which the fragment was taken. This is not correct: The fragment is a *conjunction* or *combination of several*, perhaps a great number of *individuals*, every one of which being *a real crystal*, and as such a whole, is by itself an object of contemplation for the mineralogist, when the smallness of its bulk does not prevent examination.

4. *Individuality does not require regularity of form.*—The form of those crystals (3.) is not indeed regular; but this cannot alter the truth of our proposition. They would have been regular if the space had allowed an undisturbed formation. Each of them at least, is an independent *crystalline formation*, and as such an *individual.*

5. *Distinct concretions are individuals, if not farther compounded.*—Hence any single *distinct concretion*, as we name it, is an individual, whatever be the form of that portion, provided only it is not farther combined. The magnitude of such portions has no influence on the result; they may diminish even to evanescence. A fragment of *compact* limestone is, therefore a combination of several individuals, just as really as a fragment of *granular* limestone.

6. *Examples.*—In hematite, the individuals are those line-like particles, named fracture parts of the fibrous fracture. In the balls of radiated pyrites, the individuals are those bodies that proceed from the centre towards the circumference, at which they frequently end in regularly formed points. In peastone, the individuals are the similar particles of which the spherical laminæ (the concavo-convex detached portions) consist. From these examples all minerals, in respect of their individuality, may be judged of. No solid bodies are without individuality.

7. *Simple mi* [illegible] ral which consists of one single individual is cal [illegible] neral. Simple minerals are all

essentially crystals, being all independent crystalline formations (4.) All truly undetached *compact masses* are likewise simple, because they are all independent crystalline formations, which have wanted nothing but space to assume a regular form; and this is the decisive property of individuals in the mineral kingdom. All grains, properly so called, such as those of garnet, diamond, &c. are simple, being real, though not completely formed crystals.

8. *Compound.*—A mineral consisting of several *homogeneous* (25.) individuals is named a *compound* mineral. All compact minerals in *distinct concretions*, such even as from their smallness escape the eye, as in compact galena, are compounds. Of the same character are false crystals and minerals, appearing in what are called *particular external forms.* In the kidney-shaped and stalactitic forms of hematite, in the balls of radiated pyrites, and many others, this property is perceptible even to the eye. In the kidney-shaped and stalactitic forms of calcedony, the composition cannot so easily be distinguished. It exists, however; because, if minerals of this sort were simple, being produced in free space, they would assume regular forms (7.) Any of the forms named particular, such as botryoidal, being produced in free space, is a proof of their being compound.

9. *Mixed mineral.*—A mineral consisting of several *dissimilar* (25.) individuals, is named a *mixed* mineral. To this class belong mountain-rocks, and different masses found in the shape of veins and beds. And as in this respect nothing depends on the size of the particles, which are mixed, iron-flint, heliotrope, and others, cannot be ranked among simple minerals: nor can any limit between simple and mixed minerals be deduced from the size of the particles which are mixed.

10. *Series of characters exist in Nature.*—That certain *series of crystallisations* exist in nature, has been already proved by several examples, at least so that, for the present, no farther proof of this fact seems requisite. It is well known that series are also to be observed in the colours; series in the shades of the different lustres; series in the degrees of hardness, specific gravity, &c.

11. *Preparation for forming the notion of Homogeneity.*—If in two individuals, two forms, either *similar* or belonging *to the same series,* present themselves, one of the following things must be the case: Either *those individuals completely agree with each other, in regard to their remaining characteristics*; or else, *in this respect they differ more or less.*

12. *Idea of uniformity. Examples.*—As to the first case (12), namely, when the forms are similar, it is clear that minerals in which all the other characters likewise agree, cannot be different in any point of view that regards natural history. Such minerals are named *uniform.* Similarly coloured hexahedra of calcareous-spar, pentagonal dodecahedra of pyrites, differing merely in their size or other casual circumstances (which are not objects contemplated by natural history), afford examples of this.

13. *Individuals which are not uniform. Examples.*—If, whilst the *forms are similar,* differences exist among the remaining characters, minerals of this sort undoubtedly admit a natural historical distinction, and consequently are at least *not uniform.* Examples of this are to be found in the octahedron of diamond and magnetic iron-ore; the pentagonal dodecahedron of pyrites and glance-cobalt; red, green, blue hexahedra of fluor; black, red, green rhomboidal dodecahedra of garnet, &c.

14. *In dissimilar forms, proof is requisite only for the first of those statements.*—As to the second case (12.) namely, when the forms are *not similar,* but simply members of *one series* (I. 60.); it is required of us only to produce evidence for the first of those statements (12.), that *such being their mutual relation, the individuals may completely agree, so far as concerns their remaining characters*; for, with regard to the other statement, that they may happen not to agree completely, no farther proof is necessary; nor can any of the consequences which result from that fact, be of use in the present inquiry.

15. *The proofs are deduced by means of the combinations.*—Forms which constitute members of the same series are capable of entering into combination with each other (I. 39. 49. 51. 54.) Consider now a combination of two, three, or more

simple forms. If the homologous surfaces be enlarged successively, one of those simple forms will arise after the other (I. 6.) An individual appearing in a compound form may therefore be considered as a double, triple, quadruple individual, according as two, three, four, &c. simple forms are included in the combination.

16. *Continuation, and other proofs.*—These different individual forms belonging to the same series, are connected with the resulting form of the combination. Hence different individuals, whose forms are members of *one* series, *may* completely agree in their remaining characters. This is not the only mode in which the same fact may be established. It will not be difficult to find individuals in calcareous-spar, fluor-spar, and other species, which completely agree in colour, transparency, lustre, hardness, specific gravity, &c. whose forms, at the same time, are not similar, but merely terms of the special series to which they belong. However, as the proof, conducted in this manner, applies to those species only by means of which it has been obtained; it is better, for the sake of universality, to employ the combinations, which (16.) constitute a *perfect general* relation to the mineral kindgom.

17. *The proof serves for all series of characters.*—What has now been proved with respect to series of crystallisations, namely, that different terms of such series, having a perfect agreement in their remaining characteristics, *may be* united in minerals; is also true with respect to the terms in any other series of characters. In the latter case, however, the proof can only be obtained by considering *each particular case;* and the reason is, that such series of characters admit not of mathematical treatment, by which alone universal properties can be established.

18. *Individuals of themselves not uniform, brought under the conception of uniformity.*—When individuals agree as to all their characters but one, if the differences of that one are members of the same series, it follows, from what has been said (16.), that, instead of those dissimilar members, *one and the same* may be substituted in each individual; by which means those individuals are made to agree in all respects; that is to say, they become *uniform* (13.) In a great number of

minerals, all the characters, excepting the forms, agree together with perfect exactness. These forms may be hexahedra, octahedra, rhomboidal-dodecahedra, &c. or combinations of two or more of such figures. Now, if from any individual whose form is an octahedron, that figure were removed, so to speak, and a hexahedron substituted in its place, then would this individual no longer differ from one whose form was originally a hexahedron, and so in other cases. The combinations again shew, that we are warranted to adopt this process, and to admit nothing arbitrary in our application of it. If one of those individuals appear under the form of a combination of the hexahedron and octahedron, we are at liberty either to consider its form as a *hexahedron* joined with an octahedron, or as an *octahedron* joined with a hexahedron; as a hexahedron with truncated angles; or as an octahedron with truncated angles.

19. *Individuals capable of being brought under the conception of uniformity differ in the smallest degree.*—The differences among individuals, whose forms, colours, or characters are terms of the same series, or constitute a series themselves, the state of the remaining properties being the same, are not so great as the differences of those which, under similar circumstances, exhibit no such relation. For, in the first case, if we put the members of the series equal, or substitute one member in place of all the rest, the individuals (13. 19.) become uniform. But this state indicates the *smallest degree* of difference. With the other class, however, no such method can be followed, because nothing but such characters (forms, colours, &c.), as are terms of the same series, can be interchanged or put in the place one of another (19.) Minerals of this sort cannot, therefore, *by any means* (by any regular proceeding with their characters), be brought under the notion of uniformity. The differences which occur among them are greater than those of the preceding.

20. *Separation of some individuals from the rest, leads to no conceptions of use in Natural History.*—By this process, individuals may be found and separated from every other which, though in themselves not uniform (because they shew differences in one character, whose steps or shades represent terms of a series), may yet be brought under the concep-

tion of the smallest difference of uniformity; and which are consequently more *strictly united with each other, more closely contiguous,* than such as do not admit of being so treated. This agreement, however, is of little use; because, when tried in practice, it is found that individuals, which agree exactly in all their characters but one, are of very rare occurrence, and that when the agreement in so many properties does take place, the one remaining property is also commonly the same, (the same form, the same colour, and so on,) and consequently that the individuals, being already *uniform with each other,* are not of such a kind as to render the discovery of their agreement a useful subject of inquiry. Nor does the preceding observation lead to any natural historical conception of species, genus, or other classification; and consequently, by the attainment of these objects, requires investigation to be farther prosecuted.

21. *An Individual may at once be a member of two Series.*—Upon considering abstractly a series of forms, the only one, for example, of the tessular system, and a series of colours, say those of fluor-spar, it appears that *an individual* of the mineral kingdom MAY, in regard to its form, be a member of the first series, and *at the same time,* in regard to its colour, a member of the second. Hence a mineral that constitutes by its form a member in a series of individuals, which have their other relations the same, but differ in their form, may at the same time constitute a member in a series of individuals, which, agreeing in their other relations, differ in the shades of their colour.

22. *By this means the individuals of both series are brought under the conception of smallest difference.*—When a number of individuals are distinguished solely by the differences of their forms, if these forms are members of the same series, the degree of difference among those individuals is the smallest that can possibly take place, unless when the individuals are simply uniform (20). Thus if a number of individuals are distinguished merely in the differences of their colours, those colours being members of one series; the degree of difference is the smallest that can possibly take place in consistency with the individuals not being simply uniform (20.) Hence, *when an individual is found which, considering the entire agreement of*

its remaining characters, constitutes, in regard to its form, a member in a series of individuals, distinguished only by their forms; and in regard to its colour, constitutes a member in a series of individuals, distinguished only by their colours; in that case, *the individuals of the former series disagree with those of the latter*, by the smallest degree of difference, consistent with the individuals not being *simply uniform*.

23. *Universality of the above.*—This conclusion may be prosecuted and extended to all characters, from the varieties of which series arise. When any such are found as shew no difference, which happens in some cases with respect to hardness and specific gravity, in those cases series, having *terms entirely equal*, may be imagined, concerning which the foregoing result is likewise true. By this means it is possible to find individuals which, with regard to the properties or characters combined in them by nature, may *at once be members of all the series*, which can be linked together in the way already explained (23). Though these individuals are not uniform, yet there subsists among them the smallest degree of difference, (for by the process described above, (19.), they and their characters may be included under the notion of uniformity), and they can be separated from all others *distinctly* and *accurately*.

24. *Species. Homogeneity.*—The group of individuals which, by the preceding treatment of their series of characteristics, can be brought under the notion of smallest differences, or of uniformity, is named a Species, and the individuals belonging to the same species are said to be *homogeneous*.

25. *Logical condition of the Idea of Species.*—From what has been said, homogeneity in the mineral kingdom, among individuals which are not uniform, (for the uniform are of course homogeneous,) depends on the connection which reigns among their characters. This connection is founded on the consideration of the various series of characters; among which, that of regular forms is capable of geometrical management. Were all the characteristic series possessed of the same property, homogeneity in the mineral, and *therefore the natural historical distribution into series*, would be an object of mathematical demonstration, and besides its exactness, would be attended with perfect evidence.

26. *The idea of Species needs no foreign designations.*—It is clear from this, that no *foreign* aid is required for determining the species in natural history. And as the conception of species is the foundation of all other methodical or systematic conceptions, that is to say, the natural history of the mineral kingdom requires no foreign aid, (chemical, geognostic or arbitrary,) for its foundation and complete developement.

27. *Transitions in particular characters.*—The series of shades of a character in the individuals of a species, is named a *transition.* This series, however, is nothing more than the progress of the members in a series of characters. Hence these characteristic series represent the transitions, in so far as the latter refer to single characters. Other transitions, such for example, as are produced by exposure to the weather, by mixture, and so on, are not acknowledged by natural history.

28. *Transitions of individuals among each other.*—If individuals agree together in every character but one, and if the differences of this one are terms of a series, *those individuals exhibit a transition.* Transitions, therefore, originate from series of characters; they may result from the same individuals in *more than one series* of characters (22. 24.): in forms, colours, and so forth. To secure ourselves against the numerous errors which German mineralogists have committed, it will be necessary to consider and discuss the transitions *in each character for itself;* in other words, to employ the several series with proper circumspection, and to give the characters as distinct and strict a designation among themselves, as we possibly can, or as the circumstances of the case may require.

29. *Transitions are marks of homogeneity.*—Individuals connected together by transitions are *homogeneous*, and belong *to one species.* The preceding observations render this sufficiently clear. The German mineralogy contains a multitude of examples, in which *one species is connected with another*, by means of transitions. With regard to these the two following statements may be maintained. If the transition is correct, the determination of the species must be false; and if the determination of the species is correct, the transition must be false.

30. *Connection between the Species.*—From the union of homologous individuals by transitions, it is plain, that an admirable connection reigns throughout these natural historical species (4.) *This connection is a proof of the correctness with which the species have been fixed.* It does not therefore seem advisable to divide the species; to distinguish them into subspecies, (species in the Wernerian system). At all events, such a subdivision merits entire reprobation, whenever, as has frequently happened, it proceeds without logical foundation, without logical form, and according to nothing but the author's caprice.

31. *The principle of a natural system is natural historical similarity.*—The principle which natural history follows in erecting a natural system, is *natural historical similarity.* An artificial system, on the other hand, rests upon *distributions* according to *particular* marks or characters, among which natural historical similarity is commonly lost sight of. But how different soever the two systems may be in their natures, they have yet this in common, that the *natural historical species*, as it has been explained above, must lie at the foundation of both, if they are to be useful in natural history. It appears, then, to have been a great error to give the name of *artificial systems* to certain injudicious distributions of minerals; for example, that of Brünner; and from their failure, to infer the impossibility of such undertakings in mineralogy.

32. *Possibility of artificial systems.*—When the species are determined, the possibility of an artificial system depends upon the first distribution, so that no species may, by means of it, be again split asunder. Hitherto no basis of mineralogical distribution has been discovered, sufficiently general to effect this purpose. The systems of crystallisation are fitted to effect it; and may, therefore, on the supposition that the form of certain species, which is yet unknown, will hereafter be discovered, serve as the groundwork of an artificial system.

33. *Artificial systems do not fulfil all the requisitions of mineralogy.*—An artificial system, however, is of little service in mineralogy. It can, at best, be applied only to designate varieties that may occur, as plants are designated in botany according to the method of Linnæus. After the acute Werner's

example, mineralogists have been accustomed to consider the productions of inorganic nature *in a state of* mutual connection; and after experiencing the attractive qualities of this method, one cannot, without difficulty, determine to acquiesce in an artificial system, which must be nothing more than a *simple register.*

34. *Basis of the natural historical connection in Werner's system.*—The connection alluded to rests upon the *mineralogical similarity*, which has already (32.) been exhibited as the basis of a natural system. It will be necessary to consider this relation more closely.

35. *Different degrees of natural historical similarity.*—Natural historical similarity is susceptible of *different degrees.* If the species are considered as wholes (the proper unity in classification,) some of them are found to be more, some less, similar to each other. It is evident, that native gold is more similar to native silver than to calcareous-spar,—calcareous-spar more similar to arragonite than to felspar, and so forth.

36. *Fortuitous nature of this relation.*—This relation is not a necessary one. It is conceivable, that species might stand in equal relations of similarity, might bear to each other, for example, the relation of calcareous-spar and arragonite, of hornblende and augite, of garnet and vesuvian. In that case, the combination of species, jointly similar *to one and the same*, would exhaust the contents of the mineral kingdom; that is to say, the conception originating from this conception, would be of equal compass with the conception of the mineral kingdom, which latter would be nothing else than a collection of species similar one to another in the same degree.

37. *Continuation.*—But it is likewise conceivable, that, of all the species in the mineral kingdom, *no two* might bear to each other the same degree of similarity with any other two. Of this nature are the following: calcareous-spar, heavy-spar, felspar, garnet, iron-glance, native gold, and others. Heavy-spar is plainly more similar to calcareous-spar than felspar is; felspar than garnet; garnet than iron-glance; iron-glance than native gold; and so on alternately. The consequence of this must be, that there would exist no two species which could

unite more closely with each other than with the rest, according to the measure of their similarity; and therefore *a series of single species* would result, having an extent equal to that of the mineral kingdom. The conception of the mineral kingdom would thus be changed into that of a series of *single species.*

38. *Higher and lower degrees of similarity.*—Neither the one supposition (37.), nor the other (38.), is found to hold in nature. The degrees of similarity between the different species *are neither altogether equal nor altogether unequal.* It is therefore true, that both *higher* and *lower* degrees of this similarity are found to exist; and though not necessary in this place, it would be proper to enter upon an analysis of them, in order to produce examples of this fact, if the annexed mineralogical system did not serve instead of all examples.

39. *No series of species in mineralogy.*—To convince himself of the truth that higher and lower degrees of mineralogical similarity have a real existence, and hence that no single series of species can possibly be found in the mineral kingdom,—let any one make the attempt actually to represent to himself such a series. He will soon fall upon species, concerning which doubts will arise whether the one or the other, or even a third or fourth, ought to come next in order; and at last he will feel himself compelled to assign one and the same place to two, three, or even more. Instead of single species, therefore, groups of species would result; from which it follows, that in this department, as well as in the animal and vegetable kingdoms, no regular gradation, or series of *single species*, is any where to be met with.

40. *Genus.*—A collection of species connected by the *highest*, and, at the same time, equal degrees of natural historical similarity, is named a *genus*

41. *The idea of genus is the same as in zoology and botany.* —This idea of genus is exactly the same as that which zoology and botany employ, in their natural systems. According to this idea, the wolf, dog, fox,—the lion, tiger, cat,—unite into genera; and the application of this principle is the basis on which the distribution into genera rests, throughout the whole of nature, whenever the intention is to found a natural system.

42. *Explanation and proof.*—The series of crystallisations belonging to common iron-pyrites is tessular. If, according to the method just explained, we collect the varieties of a species, we shall meet with numerous individuals, which almost entirely agree with common iron-pyrites in all their characters,—in colour, hardness, specific gravity, streak, and so on; but whose crystalline forms belong to the prismatic system. It is these varieties that Werner had named radiated, hepatic and cristated iron-pyrites. Individuals whose forms belong to two different systems of crystallisations cannot be united in the same species. Radiated hepatic and cristated iron-pyrites, therefore, constitute a distinct Species. Yet this species is so similar to that of common iron-pyrites, that we must either unite them *into one Genus*, or relinquish all sort of methodical arrangement.

43. *Universality of the idea of genus.*—This idea of natural historical genus finds scope for its application, every where in the mineral kingdom. Yet the similarity on which it rests, if we regard it as constantly of the same degree, is not always so obvious as in these examples. Magnetic iron-ore and brown iron-ore belong to one genus. At first sight we can discover no great similarity between the varieties of these two species. But iron-glance and red ironstone belong also to this genus, and together form *one species*. This explains the difficulty. Between magnetic iron-ore and the crystallised varieties of iron-glance, as well as between red hematite and brown hematite, it will be easy to discover the similarity on which this combination into one genus is grounded.

44. *Caution in fixing the genera.*—In investigating that similarity of species, on which the distribution into genera depends, it is necessary, therefore, to pay attention to the particular condition of the varieties, to compare simple with simple, compound with compound, and so on. Upon the whole, the distribution into genera, if it does not degenerate into a mere arbitrary division, depends much more on a judgment perfected by practice, than the distribution into species.

45. *Except in Werner's system, no trace of genus.*—It is well known, that one meets with no vestige of a natural historical genus, in any mineralogical system hitherto published, excepting that of Werner. So completely has natural history been forgotten

in treating mineralogy! Werner's natural historical genera (his *Sippschaften)* are not, however, capable of being used; partly because the species are not correctly fixed, and partly because the *chemical* genera have prevented the junction of congruous species. This latter circumstance is the reason of there being so few natural historical genera in the class of metallic fossils.

46. *Universal application of genus.*—Many genera comprehend only one species; but no genera are to be found, (as in Karsten's Tables,) which do not comprehend any species. Indeed a consistent and regular system can comprehend no species without including it under some genus; though that genus should even be the only one of its order (51). The idea of genus must, therefore, be applied over the whole mineralogical system.

47. *Series of genera.*—The reason why no series of species are to be found, in examining the productions of inorganic nature, lies in this circumstance, that, several of those species assume at once the same position, and form groups (40.) These groups are the natural historical genera. Hence *the mineral kingdom consists of a series of natural historical Genera*, every one of which comprehends similar Species (41.), every species, in like manner, comprehending homogeneous Individuals (25.) The conception of the mineral kingdom is by this means made more distinct.

48. *Genus and Species are the essential steps of Classification.*—From these considerations, it follows, that *genus* and *species* form the two *essential* steps of classification in the mineral kingdom: in other words, they are the only means necessary to be used for obtaining a distinct representation of that kingdom. But the mineralogical system, in order to be applicable to nature, (that is, to the distribution of minerals, as plants are usually distributed,) requires some *more extensive* groups to be presented; and for this purpose, the degrees of similarity yet remaining may properly be used.

49. *Foundation of greater Groups or Collocations.*—Select any genus from the mineral kingdom; say that to which pyrites belongs. It has already been produced as an example (43.) So far as we yet know, it consists of three species. The first is common pyrites, the second includes radiated, hepatic and cristated pyrites,

and the third magnetic pyrites. Let this genus be considered as a fixed point, and collect around it such species (already united into genera,) as possess the greatest similarity with the species contained in it. It is clear enough that this junction must not be founded on the mere superficial appearance, but on a comparison of all the natural historical properties they possess. The species collected will be arsenical pyrites, copper-nickel, tin-pyrites, and copper-pyrites. If we endeavour to join more species with those already enumerated, it will be found to be impossible, unless we choose again to destroy the relation, which has arisen from the juxtaposition of the preceding species, and hitherto maintained a definite sphere of union. Let us farther select lead-glance: To this grey antimony, molybdena, black tellurium, vitreous silver, bismuth-glance, will unite themselves. Select the genus of iron-ore: To this grey manganese-ore, chrome-ore, cerium-ore, titanium-ore, tin-ore, wolfram, and others, unite themselves; and being properly divided into genera, these substances will exhibit well defined groups, which correspond exactly to the natural families in the vegetable kingdom, and which, springing from the same principles as those families, are consequently of equal use with them in the natural system.

50. *Idea of an order*.—The union of such genera is founded on a particular degree of natural historical similarity (39.), the *closest* after that from which the genera originate (41.) The collection of genera united by this degree of similarity is named an *order*.

51. *Its Universality*.—This idea of natural physistorical orders may be extended through the whole mineral kingdom. Hence, there is no genus which does not extend under some order, as there is no species which does not stand under some genus. The regularity and uniformity of the system requires it to be so. Yet the fixing of those orders in such a manner as to be applicable and conformable to nature, is attended with difficulty; just as difficulties occur in effecting this for botany. An attempt to attain this object will be exhibited afterwards. We must look to futurity for improvement.

52. *Traces of this idea in the older Mineralogy*.—The idea of natural historical orders in the mineral kingdom, appears to be

one with which the older mineralogists were acquainted. Certain names, which have descended to us from those times, indicate this fact. The name *pyrites* has been applied to several minerals which do in reality belong to one order. This being the expression of unwarped and unprejudiced judgments, may be regarded as the first sketch of a natural system.

53. *Classes.*—As the genera may be collected into orders, the orders in like manner may be collected into *classes.* Three such classes are to be found in the mineral kingdom. At present, it will suffice to mention what is included under them, as by this means their differences, and the facility with which they may be characterised, will best appear. The first class comprehends the salts and the atmospherilia, as they are called; the second comprehends the earthy and metallic minerals of Werner's system, with sulphur and graphite; the third comprehends combustible minerals, excepting sulphur and graphite.

54. *Why Atmospherilia are introduced into the Mineral Kingdom.—Idea of a Mineral.*—The only thing here deserving notice is the introduction of atmospheric substances into the mineral kingdom. This results from the very idea of a mineral. According to Werner's explanation, this term includes under it the idea of geognostic indications, which are specified for the express purpose of excluding atmospheric substances. But the idea of a mineral in natural history ought to be *purely natural historical,* and must not, therefore, have a reference to indications of a foreign kind. If such indications are omitted from Werner's system, the only remaining principle is, that *minerals are inorganic productions of nature,* as atmospheric substances likewise are.

55. *Idea of Mineralogy and Natural History.*—In order finally to combine all the preceding results under one point of view, *the scope of mineralogy itself* must be taken into consideration. If mineralogy, as almost every writer acknowledges, at least *in the first page* of his work, is a department of natural history, and consequently the natural history of the mineral kingdom; then it must serve the same purpose for this kingdom, as zoology serves for the animal, and botany for the vegetable kingdom. Of all the departments into which natu-

ral history has been divided, botany is the most complete and advanced. The idea of natural history may, therefore, be developed best by considering this division of it. Now, *botany is* nothing else than *the science of finding the systematic name* OF A PLANT, *from its known or observed natural properties*, that is to say, by means of its characters, *or of finding the natural properties when the name is given;* and all the arrangements, subdivisions and collocations employed by this science, are directed to that purpose. Natural history is therefore nothing else than the science of finding the systematic name from the characters of *a production of nature generally*, or *vice versa;* and mineralogy nothing else than the science of finding the systematic name from the characters of *a mineral*, or *vice versa;* and whatever has no reference *to that object*, does not belong to the science.

56. *Geognosy, Mineralogical Chemistry, &c. are essentially different from Mineralogy.*—Now, neither geognosy, nor mineralogical chemistry, nor mineralogical geography, nor economical mineralogy, propose as their object to find the name from the characters. Consequently, they are sciences altogether distinct from mineralogy, and though treating the same subject as mineralogy, they treat it in quite a different point of view, and upon quite different principles. Every science ought studiously to be maintained in a state of purity, if we would screen it from final ruin, which, as exemplified by natural history in the mineral kingdom, is otherwise unavoidable. Hence, nothing geognostic, nothing chemical, nothing geographic, is suitable in mineralogy. It need hardly be mentioned, that in making these observations, I do not mean to censure the practice of bringing forward descriptively in natural history such notices from other sciences that concern the productions of nature, as may illustrate the subject. Still less do I intend to take from those sciences any portion of their credit. Indeed, it is abundantly clear, that, according to the opinions unfolded above, mineralogy, and the whole of natural history, is nothing but the mean of turning to profit by these modes, *the proper knowledge* (the true scientific knowledge) of the productions of nature; such productions, of course, as natural history does not reject:—*so that we are not only to acquire much*

useful knowledge from those sciences themselves, but also to understand and distinguish the objects from which we have acquired it.

III. *Nomenclature.*

1. *Nomenclature exhibits the scientific condition of Mineralogy.*—In every department of natural history, nomenclature is a mirror in which the whole science is represented. The image which this mirror reflects back upon mineralogy, has so few charms, that it seems to have repelled zoologists and botanists from studying the productions of inorganic nature; although such persons, from their peculiar pursuits, would have been completely prepared, and well fitted for the investigation.

2. *Why it has not been improved.*—The discontent with our existing systems of mineralogical nomenclature is universal. This feeling has not, however, produced any advantageous consequences. *Names* only have been altered without the principle being improved; and no result has followed from this procedure, but an almost intolerable synonimy, which is certainly a negative advantage.

3. *What it must accomplish.*—In natural history, nomenclature has *two* purposes to fulfil: The first is to provide every species with a name; the second to indicate, by means of that name, the natural historical relation and connection, in which it stands to one or more other species.

4. *Nomenclature must be systematic.*—The general expression of that natural historical relation, in which the species of natural productions stand to each other, is the *natural system.* Nomenclature in natural history must, therefore, be *systematic*, in other words, it must arrange itself according to some system, and express the connection in which the different species of natural productions stand to each other in that system.

5. *Trivial Nomenclature.*—A nomenclature which is not systematic, bears the name of *trivial* nomenclature. A trivial nomenclature may indeed subsist with, but not without, the systematic nomenclature; because it fails to satisfy one of the requisite (3.), and that the most important requisite, of natural history.

6. *Why no Systematic Nomenclature has yet appeared.*—The want of a systematic nomenclature in mineralogy is capable of being accounted for. A systematic nomenclature presupposes a system, according to which it may be constructed (4.) Such a system has not hitherto been discovered. A mineralogical system must be natural historical, for mineralogy is a department of natural history. It must also depend upon a single principle; for otherwise it would not be a system at all. A system resting on more than one principle would be deficient in unity and consistency; and, therefore, could not express the congruity that subsists throughout the productions of nature. Among all the mineralogical systems which have hitherto appeared, there has not been one of a natural historical character, or one grounded on a single principle.

7. *The Nomenclature has a reference to the nature of the science it is used in.*—Chemical systematic denominations, when they appear in mineralogy, are altogether out of their proper place. These denominations, it is clear, express chemical relations, chemical connections of natural productions among each other, with which natural history, and consequently mineralogy, has no concern. The nomenclature is intimately connected with the nature of the science for which it is to serve. From the use of chemical names in mineralogy, it would follow that mineralogy must be a department of chemistry. But mineralogy is a department of natural history; and that chemistry is natural history, or natural history chemistry, will be maintained by no one, not even a partisan of the chemico-natural historical system of mineralogy.

8. *Its structure may be unfolded from the idea of it.*—From the idea of a systematic nomenclature: "That it is a *verbal* expression of natural historical connection subsisting among the productions of a series, or a verbal expression of the system which represents these connections,"—it is easy to unfold its structure.

9. *Names and denominations.*—The word with which we designate a single object is called a *name*. This object may be such as to include a number of others. If the name has an epithet annexed, it is called a *denomination*. This denomina-

tion no longer designates that object on which the name was bestowed, but some single object included under it; and this last may, in its turn, include other objects. This distinction between names and denominations will afterwards be useful on account of brevity.

10. *Denominations alone are capable of expressing the union of objects.*—By names alone no mutual relation of the things which bear them can ever be expressed. A denomination affects this; the name, by its annexed epithet, marking a stricter designation. Hence, in a systematic nomenclature, the *species* bear denominations, not names.

11. *Name is given to one of the higher steps of Classification.*—To give the name a more definite signification in the case of the species, it is applied to the genus, or the order, or some of the *higher* steps of classification. The name refers not to *one single production of nature*, or to *one species*, but to a class of greater extent; it reaches to the former only in so far as their characters entitle them to a place under that class. It is by this arrangement that the systematic nomenclature is enabled to restrict the arbitrary application of names. A newly discovered mineral, though not belonging to any known species, would probably belong to some known genus, and therefore obtain the name of that genus, or to some known order, and hence take its name from that order.

12. *In Mineralogy, to the order.*—The division to which names must be applied, whether to the genus or to the order, depends npon the constitution of those productions of nature for which the nomenclature is contrived. In zoology and botany, the name depends upon the genus: Generally it is the rule that the name be not given to the genus. It is a universal principle, that we should endeavour to combine all the advantages which a systematic nomenclature can afford to any department of natural history, and apply the names in such a manner as to secure this object most completely. In mineralogy, without question, this happens when the order bears the name; and for that reason I have applied it to the order.

13. *Choice of the Name.*—In a mineralogical nomenclature, the choice of names is a matter of importance, and at the same

time attended with many difficulties. Having made it a rule to introduce as few new names as possible, I have borrowed from the *German* mineralogy, particularly the older systems of it, as many designations as seemed applicable. In its present state, the nomenclature is therefore a German one, but if requisite, it may easily be converted into Latin.

14. *The nature of the order to which a mineral belongs, settles its Name.*—The names I have employed are, *pyrites, ore, glance, spar, &c.* The term *pyrites* has already been applied to certain minerals belonging to one order, (II. 53.) I have therefore employed it to denote an order. Some other substances, which likewise belong to that order, have therefore necessarily received this designation, and laid aside their previous names,—nickel, for example, glance-cobalt, and others. *The signification of the order settles what is or is not pyrites; and whatever, according to that signification, is pyrites,*—in other words, whatever belongs to the order bearing this name, *must also be called pyrites.* The same kind of management has been followed with the other names, as may be seen by inspecting the mineralogical system, to which the new nomenclature is applied.

15. *Closer settlement of the Name belonging to the Order.—Generic Name.*—Next to the name, the most important point is the first restriction of it, that adjunct, to-wit, by which the name of an order is transformed into *the name of a genus.* The generic name ought to be founded on the natural historical nature of the genus. Of this kind are *garnet-blend, ruby-blend, glance-blend.* These three genera all belong to the order of blends. The first, however, has the appearance of garnet; the second, at least in some varieties, of ruby; the third of *glance.* This mode of forming the generic name would, doubtless, be the most advantageous, because it leads to no delineations which are foreign to natural history. It cannot, however, be universally applied, without introducing a multitude of new names; and hence, in conformity to the previous rule, with the sacrifice of uniformity it is true, two other means have been attempted. The first is to make use of some customary trivial names for settling the genera; the other to apply to this an arrangement not properly

arising from natural history. On the former principle are *felspar, augite-spar, azure-spar;* on the latter, *iron-pyrites, cobalt-pyrites, lead-glance, molybdenum-glance,* and others. No doubt, the second class of names have a chemical sound; but they have no chemical meaning; *and all depends upon the meaning.* Of a similar, yet not altogether identical nature, are *fluor-haloid, calcareous-haloid, gypsum-haloid;* but not less exceptionable in that respect.

16. *Apparent exceptions.*—In conformity with zoology and botany, the adjunct, by which the name of an order is changed into that of a genus, is coupled with the original term, and forms a *compound name,* which thus belongs to the genus (12.) An exception from this arrangement seems to take place in the orders of metals and gems. The name of the order, however, is in these cases merely suppressed, being sufficiently apparent without mentioning. Every one knows that gold, silver, tellurium, bismuth, &c. are metals; and the generic names, gold-metal, silver-metal, &c. could scarcely be tolerated. Such also is the case with diamond, topaz, zircon, and others. Diamond-gem, topaz-gem, &c. would be awkward terms. The name of a metal or of a gem, sufficiently points out the order to which the one or the other belongs.

17. *Farther restriction of the Generic Name.—Denomination of the Species.*—The farther restriction of the generic names, is brought about simply by means of an adjective, indicating the system of crystallizations, or some relation of the cleavage, or in general, that character by which the species of a genus are most advantageously distinguished. Such are *hexahedral, prismatic, rhomboidal* iron-pyrites; *rhomboidal, octahedral, prismatic* corundum; *octahedral, rhomboidal, prismatic* iron-ore, and many others. When the forms of two species in a genus belong to the same system of crystallizations, the same process is followed; to the one adjective is joined another, by which the nature of the cleavage is more accurately denoted. This has been done in cases such as *rhomboidal* and *prismato-rhomboidal* ruby-blend, *pyramidal* and *prismato-pyramidal* titanium-ore, and the like. In these instances, no idea must be entertained of the transposition or mingling of two systems of crystallizations. In the first

example, the denomination merely signifies, that the form of the species belongs to the rhomboidal system, and that the cleavages, on the other hand, takes place according to prisms, which (I. 22.) can be no other than regular six-sided prisms. In the second example, the denomination indicates, that the forms belong to the pyramidal system, and that the cleavage takes place according to prisms, which must, therefore, (I. 44.) be rectangular four-sided prisms. When the system of crystallizations and the cleavages of two or more species agree, as in several calcareous haloids, augite-spars, and others, a particular property of the crystallizations, &c. is chosen to form the special denomination; such as *long* or *short-axed*, *right* or *oblique angled*, and so on. The term *axifrangible* or *axis-cleaving*, denotes a particular direction of cleavage perpendicular to the axis, as in axifrangible zeolite; *prismatoidal* denotes one particular direction of cleavage, parallel to the axis, as in prismatoidal antimony-glance. Few adjectives have been borrowed from colours, countries, and other such peculiarities; and "*common*," the worst of all epithets, though it abounds in German writings, has not been used at all.

18. *How the Systematic Nomenclature is to be judged of.*—A systematic nomenclature must be estimated solely by the system from which it is deduced. If that system is founded on relations which constitute an object of the science under consideration: if it is consistent with those principles, and possesses, besides, the other requisite qualities, in that case, the duty of a nomenclature extends no farther than faithfully to represent that system *by denominations*. If it accomplish this,—if it be conformable to the usual modes of speech,—if it reject unnecessary innovations, and at the same time introduce a description of the object into each of its denominations,—it will then have fulfilled its chief obligations, and may quietly entrust its improvement and refinement to the diligence and reflection of future times.

19. *Trivial Nomenclature not to be thrown away.*—It cannot be called a hurtful practice to give the productions of Nature, particularly those which frequently come under our management, for other purposes than those of science, such names as

are more conformable to custom than systematic ones, and as are fitted, so to speak, for familiar use, the properties of the object being exhibited, or at least not obscured by its designation. Beyond this, however, entirely to relinquish systematic names, as it abstracts from science a powerful help to its easier extension, must be a very censurable mode of proceeding.

20. *The Trivial Name depends on the Species.*—By using the trivial nomenclature, not only our knowledge of the object, but also of the connection in which it stands with others, is expressed. The trivial name is hence never applied to an order or a genus; and upon this circumstance is founded the convenience of employing such names, which on that account can never be compounded. Neither trivial nor systematic names ought to reach lower than the species, which it does not seem (II. 31.) advantageous to divide.

21. *Properties of a Trivial Name.*—The first, the essential, but also the only property of a trivial name, here to be considered, requires it therefore to consist of a single word. Of this kind are *spinel* for octahedral corundum; *euclase* for prismatic emerald; *rutile* for prismato-pyramidal titanium-ore, forming very suitable designations. But what are we to think of compound trivial names? Whoever uses them, imposes on himself, without necessity or advantage, a burden which it is the sole intention of a trivial nomenclature to remove.

22. *Compound Trivial Names are to be rejected.*—A compound trivial name assumes the appearance of a systematic denomination. Whenever, therefore, such a name is not deduced from a system, or even not from that system, in which it is employed, it can serve for nothing but to embroil those conceptions which it is the main object of the whole science to unravel. It costs labour to forget the notion that hornblend, coal-blend, are species of *blend*; and when in *one* genus we meet with such names as native copper, copper-glass, variegated copper-ore, azure copper, copper-green, and so forth, in that case, the best thing we can do is to veil the mirror, that no botanist or zoologist, at least, may observe the image traced within.

(To be concluded in next Number.)

ART. XVII.—*On a Singular luminous property of Wood, &c. steeped in Solutions of Lime and Magnesia.*

ABOUT the middle of last summer, Mr Cameron of Glasgow, (the inventor of the ingenious method of making crucibles, described in our last number,) brought me some pieces of wood that had been steeped in oxymuriate of lime, the common bleaching powder of Mr Tennant, and mentioned to me, that he had observed a singular luminous property in the white substance which remained after burning the wood. In order to observe this appearance, the end of the piece of wood is held in the flame of a candle till it is completely burnt. A sort of white substance is left at the end of the wood, and when this substance is held in the outer part of the flame of the candle, it exhibits a brilliant dazzling light, not much, if at all, inferior to that which arises from the deflagration of charcoal by the action of galvanism. When bits of woods of different kinds were steeped in the oxymuriate of lime, they gave the same results, only the harder woods seemed to produce a more satisfactory effect than the softer kinds.

By submitting the whole substance to the action of the blowpipe, I found that the intensity of the light was greatly increased, but the white substance was generally driven away by the blast.

Upon shewing this experiment to Mr Sivright of Meggetland, he conjectured that the white residue of the burnt wood consisted of particles of lime in a minute state of division, and we found upon trial, that it was soluble in nitric acid. Dr Fyfe, to whom I gave a portion of the ashes, found them to be pure lime, and also ascertained that wood acquired the same property by being steeped in solutions of the salts of that earth, or in lime-water. I obtained a similar result by steeping the wood in a solution of sulphate of magnesia; but no effect was produced when it was steeped in a solution of hydrate of barytes. The calcareous residue was highly phosphorescent, when thrown upon a hot iron, but the magnesian residue exhibited no symptoms of phosphorescence.

The sight of these experiments naturally suggests the idea, which occurred also to Mr Cameron, that such a brilliant light, capable of being developed by the heat of the flame of a candle, might have some useful application. In order to obtain some information on this point, I prepared three or four pieces of wood terminated with the white masses of absorbed lime, and placed these masses so as to remain near the circumference of the flame of a candle. In this situation they yielded the brilliant light already described, and lasted, without any apparent diminution, for more than two hours. I next prepared a very thin slice of chalk, and having held it in the flame of the candle, I found that it did not give the same brilliant light as the absorbed lime. Upon exposing it, however, to the heat of the blowpipe, it emitted the same white and dazzling light which has already been described.

In order to observe if the minute particles of the lime and the magnesia would remain in the pores of *Tabasheer*, and give out their light when laid upon a hot iron, I took two pieces of Tabasheer, and having discharged their natural phosphorescence, by exposing them to a high degree of heat, I placed one of them in lime-water, and the other in a solution of sulphate of magnesia. When the pieces of Tabasheer were dry, I then put them upon a hot iron, and found that the piece which had been placed in the lime-water was considerably phosphorescent, while that which was immersed in the magnesian solution discharged no light at all.

As this light seems to be developed by degrees of heat inversely proportional to the minute state of division in which the particles of lime are combined; it is highly probable, that denser kinds of wood, in which the pores are very small, might leave, after combustion, a residue in which the lime exists in a much more attenuated state than that which I used, and therefore the same intensity of light might be evolved at a temperature still lower than that which exists at the edge of a common flame. If this should turn out to be the case, the light of the lime and the magnesia might be developed at a temperature lower than that which discharges the phosphorescent light of minerals, and it might have a most extensive and useful application, both in the arts and in domestic economy. Even in the present state of the fact, the subject deserves farther investigation. D. B.

EDINBURGH, *July* 29. 1820.

ART. XVIII.—*Account of the Sepulchral Caverns of Egypt.* With a PLATE. By COLONEL STRATON, C. B., 6th Dragoons. Communicated by the Author.

THE Lybian chain of rocky mountains borders the western side of the Nile, and the Djibel Mokattem, the eastern side, sometimes approaching close to the river, at other times receding to a distance of several miles.

At Thebes, the cultivated plain is very extensive on the eastern, while it is more limited on the western bank, and, on both, the country is extremely fertile; the dourra, or large millet (Holcus Durra,) attaining the height of six feet *.

On the western side, the rock is excavated into sepulchral caverns, forming the Necropolis of ancient Thebes, and now very generally occupied as dwellings by the population of the village of El Gournou. Some of these catacombs have a covered entrance, or vestibule, cut out of the rock, leading to a gallery, with mummy-pits on both sides, and at the extremity. In others there is no porch, but a descent, either perpendicular, on an inclined plane, or by steps in the rock, to a painted chamber, containing sometimes a few mummies, the greater part being deposited in pits, which are more sunk than the chamber. In the descending passage, as well as in the chamber, the sides and ceiling are polished as highly as wrought marble: The stone thus polished is remarkably white, and frequently is covered with a stucco quite as fine as plaster of Paris, of the most dazzling whiteness, and often, but not always, highly varnished. On the sides or walls thus prepared, are represented the feats of a hero, scenes drawn from the agriculture, manufactures, commerce, sports and amusements of the ancient Egyptians; or, we find representations illustrating their progress, in those remote periods, in the arts, the sciences, and in the luxuries, refinements, and elegancies of life, or depicting a wide range in mythology, from which the Greeks and Romans have borrowed largely. These pictured representations are intaglios, relievos, or painted on the surface: the colours are, from the almost complete exclusion of the atmospheric air, in many sepulchres, as vivid as if recently laid on; in all the tincts most subject to fade, are, from the aridity of the climate, clearly discernible. The ceilings are not unusually painted in small squares, somewhat like the painted flooring-cloth used in halls and lobbies.

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* It is the staple of the country: the bread is made from it.

The mummy-*pits* are generally roundish in shape, with the sides and ceiling rough. The mummies are enveloped in numerous folds of a sort of linen stuff, impregnated with gummy and resinous matter; the most common sort have no other covering: a second class has a covering of cement or stucco upon canvas, made to adjust itself to the body, and painted with figures and hieroglyphics,—a human face, probably that of the deceased, is frequently painted on the case: A third class of mummies, thus doubly enveloped, are laid in a wooden case, sometimes thin, at other times of very considerable thickness, and more or less ornamented with paintings. The upper part of the case is furnished with wooden pegs, and the under with holes to receive them; while some are further secured by cross pegs. The wood is generally in perfect preservation, and I believe invariably of sycamore; pieces of date-tree are found in the caverns, but on handling them, they crumble to dust. The mummy cases are also found immersed in bituminous matter, so adhesive, that in removing them, the bottom part remained in the preparation [*].

All the mummies were laid horizontally; though Dr Shaw, I think, says they were placed perpendicularly. The horizontal position is further confirmed by the pictured representations of mummies in the sepulchres. The male mummies had generally the hands placed over the middle; the female across the chest.

The entrance to the newly discovered caverns, was found barricadoed by a wall, and covered up with heaps of stones. Barriers of stones or of the rock are also found in the galleries, and the passage intersected with a deep cavity.

The sepulchres in the valley of Biban el Moluk (called the Tombs of the Kings), at the distance of seven or eight miles from the western bank of the Nile, are much more extensive, and infinitely more magnificent. Many of them contain a sarcophagus of granite, and one has a sarcophagus of alabaster.

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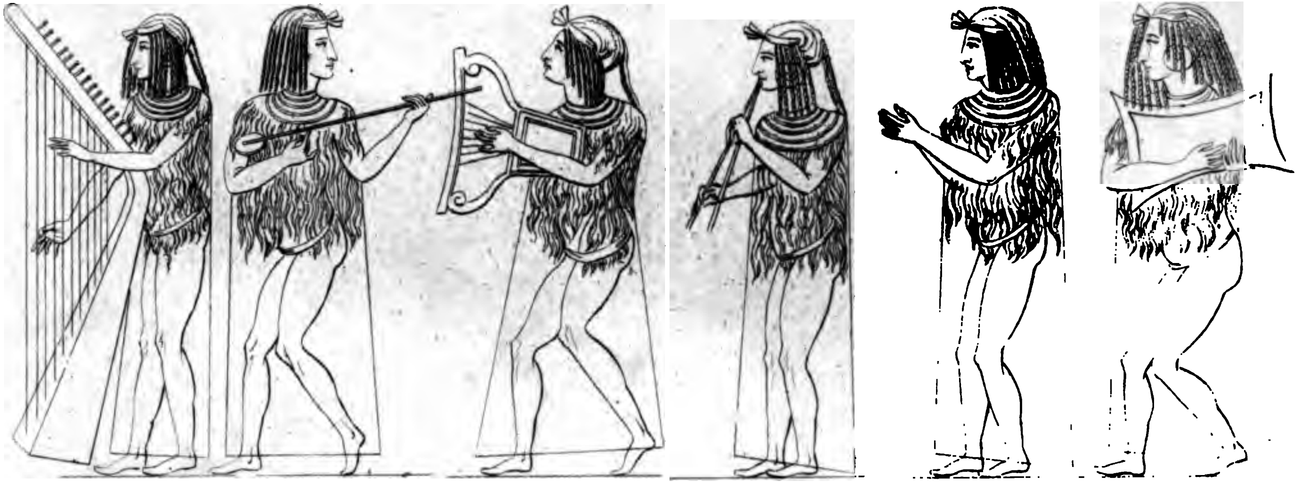
[*] A very perfect mummy from Thebes, was presented to the University Museum of Edinburgh by Colonel Straton.—Ed.



W. H. Lizars Sculp.

Edinburgh Published by A. Constable & C° 1820

In the cavern where the dancing girls are painted on the walls, the first figure, on entering, is a male harper sitting, as is still the practice in these countries, with his legs across: his head is shaved; and the harp has nine strings. Then follows the group of dancing girls, represented in Plate X. The upper part of the dress is red, and resembles hair; the lower part is white and transparent, without any folds. On a pannel above, in the same room, there is a row of five females seated, some on camp stools, others on chairs with four legs. Each of these females holds a lotus flower in the right hand, turned towards the nose, and the left hand rests on the knee. In the pannel under the dancers, is another row of seated females; the hair is matted, thickened, and made wig-like, with grease or oil, exactly as the Nubians of the present day wear the hair *.

On the adjoining wall is a seated female, having on her knee a young boy, his face turned towards her, holding the crook in his right hand, and the sacred Tor in his left, with a figure of the Scarabæus suspended from his neck, like the Bulla worn by the Roman youth of distinction. From the attributes, it is probably meant to represent Isis and Orus.

On another wall are two harpers cross legged. One of the harps has seven, and the other fourteen strings.

The Almé, or dancing-girls of the present day, make use of the same instruments that are represented in Plate X. with the exception of the harp, which is unknown to the present inhabitants of Egypt. A mummy-pit adjoins the chambers, containing several mummies in a tolerable state of preservation, but none of them were in cases. They were all in linen, which was wrapped round in vast quantities; this linen had a border and fringe, and was, as well as the thread, in perfect preservation. I had been assured that rolls of papyrus were often found under the armpits, or between the thighs of the mummy, but here I looked for it in vain. I bought some rolls from peasants, who asserted that they found it thus placed. Some sandals were also brought to us, found in a sepulchre: one pair was very perfect, the upper part green, and the toe turned up, like the present Turkish slipper. The

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* I have been told, that the oil used for thickening the hair is obtained from the oily grain of the sesamum, (Sesamum Indicum,) which abounds; it serves to protect the head from the sun.

sole consisted of three distinct layers of whitish tough leather, resembling chamois. The sewing and stitching was very neatly executed: whitish thongs, nicely plaited, were attached to the sole. The figures in the sepulchres and temples are, however, generally barefooted, and I observe only one instance, where I have noted them as having sandals on the feet.

In another sepulchre, 22 yards long by 21, is represented a figure, probably a Deity, with a very high cap, holding a rod (the *hasta pura* of the Romans,) in both hands: a female figure presents to him a leg of the gazelle*. The cap is yellow, the dress white, with a yellow scarf over the shoulder, and bracelets and armlets of gold. The female wears a white dress, the under part of thin transparent stuff, like muslin or gauze; the skin, always painted reddish, appears through it. Her eyes are black, rendered larger to appearance, and elongated at the corners, by means of black paint. At present, the females of this country, and even sometimes men, dye the eyebrows with galena or lead-glance, called in the Levant Alquifoux; it is reduced to a fine powder, and mixed up with the fuliginous vapour of a lamp. The eye-brows and eyelids are painted, and the lashes are blackened, with a reed or quill, which is passed lightly between the eye-lids. The angles of the eye are also tinged, and prolonged, which makes it appear larger and more oblong. The ancient Egyptian ladies in many instances, and the men, in one, (at Ipsambul,) are represented as having resorted to the same arts of the toilette. Juvenal satirizes the Roman ladies for this coquetry:

> " Illa supercilium, madida fuligine tactum,
> " Obliqua producit acu, pingitque, trementes
> " Attollens oculos." Juv. Sat. ii. l. 93.

In these sepulchral caverns, are frequently found small brooms, of the stuff of which we make mats; small figures of the human body, sometimes with the human head, at other times with the head of a cat, dog, scarabæus, &c. &c. These caverns have been selected for description, not on account of their extent or interest, but solely from their not having been known to former travellers.

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* Presentations of parts of animals, birds, bread, flowers, libations, &c. &c. are very common.

ART. XIX.—*On the Volcano, called by the Japanese* Coosima, *and situated in the neighbourhood of Cape Sangar, in the Archipelago of Japan.* By Dr TILESIUS, Russian Counsellor of State, and Member of the Imperial Academy of Sciences of Petersburgh, of the Wernerian Natural History Society, &c. &c. &c. Communicated by the Author.

THE smallest volcanic rock, in a sea of islands, can only be regarded as the peak or summit of the mountain, projecting but a short way above the surface of the water. The first voyage of the Russians round the globe, in the years 1803—6, under the command of the honourable and learned Captain Krusenstern, by whom I was appointed to the situation of natural historian, gave me an opportunity of making a near survey of a small volcano of this kind, and of sketching it on four sides. After our departure from Japan, in the month of May 1805, when we had passed Matmai and Cape Sangar, and were directing our course towards the Kurile Islands, and Kamskatka, we fell in with the two small volcanic islands *Oosima* and *Coosima.* Krusenstern himself, in the second part of the account of his expedition, pages 30, 33, and 34, has described this voyage with all its details, and takes this opportunity of representing both these islands, and their nearest-lying promontories, *Cape Sinecko*, *Cape Sangar*, and *Cape Nadeschda*, the town *Matsmai*, *Cape Greig*, and the *Peak Tilesius*,—whence it is already known that all the rocks of this archipelago are more or less of a volcanic nature. In the chart of the Strait of Sangar, (from the same atlas) Krusenstern has represented these two volcanoes, which are still continually smoking, as lying between 139° and 140° longitude, opposite to Cape Sangar, or between this and Cape Greig, along with which they form a triangle. There is a view from them of Cape Gamaley, and of Peak Tilesius. They are drawn on the great scale in Tab. 68., or in the chart of the west coast of Jesso in the atlas of Krusenstern. From this point there is a view of Okosir and Cape Sinecko, of Cape Gamaley, and the peak Tilesius. The islands lie directly in the sight of the Japanese town Matza or Matzmai. I have also given a sketch of the sea views of the neighbouring coasts. It is necessary to have examined these views and charts, and to have read Krusenstern's account of the neighbouring promontories, in order to have a comprehensive and distinct idea of the whole of this volcanic archipelago.

A person who has seen the great volcanoes of islands, which rise to a vast height above the sea, as, for instance, the Peak of Taide, in the island of Teneriffe, and the volcanoes of Kamskatka, namely, Opals' Kaia Sopka, Wilnitschinskaia Sopka, Tschupanoios' Kaia, and Awatschinskaia Sopka, but especially Straelesohnaja, Kronotzkaia, and Goraeta Sopka, in which the process of the formation and raising of a volcano is not so obvious, although, from its colossal height, the mountain itself cannot be overlooked:—Such a person is astonished at the sight of a volcano so small, that, with one glance, he can have a complete view of it, while its summit, in utter nakedness, rises from the sea,—and the cause of its formation, elevation, and eruption, is also made perfectly obvious, namely, the action of the water which surrounds on all sides the higher part of the rock, and passing thence into the interior laboratory of the mountain, assists in kindling the combustible matters contained in it.

One of these small islands, Coosima, whose point only projects above the surface of the sea, and which forms, perhaps, the most diminutive volcano in the world, is a peak or pointed rock *(Spitzberg)* which smokes incessantly. It was measured on the 4th of May 1805 by our astronomer Dr Horner, and was found to rise only to the height of 150 fathoms above the level of the water. It lies in 41° 21′ 30″ N. Lat., and 220° 14′ 45″ W. Long., and is naked, and of a dark-blue colour. No herbage springs on this lava-rock, whose weather-beaten, dark-red, and porous skirts, lying like terraces in the shape of steps above each other, and springing in the form of an amphitheatre above the sea, distinctly point out its nature. The other island, Oosima, not far from Coosima, probably one of its summits, is larger, lies more to the west, and is in 41° 21′ 30″ Lat. and 220° 14′ W. Long. It is in all respects like the former island, and the view through the telescope discovered the same composition of its rocks, the same colours, and the same barrenness. We sailed between these two islands, which are at the distance of but six English miles from each other. The depth of the safe course for sailing was unfathomable, since, from caution, we kept sounding during the whole of the passage, but we could find no bottom in the channel with 100 fathoms of line. It was only, therefore, the summits of the volcano which we saw. Hence there is here also an unusually strong current; and just as we were sailing through the channel, changeful calms took place, so that we committed ourselves to the current, and our ship, the Nadeschda, sailed thrice around the small volcano Coosima, so near to it, that I could sketch it at my leisure from four sides during this circumnavigation, and could look from the mast downward into the crater, and other apertures of the mountain. I could, in the space of half an hour, have ascended to the summit, and gone round it on all sides, so favourable was the opportunity; but we were afraid of gusts of wind which might come, and, on that account, no boat was launched for me. I was often so near the rock, however, that with great ease I could have thrown a stone to it from the mast, and could distinguish, with my naked eye, all the small pieces, rolled masses, dross, porous brown dross, and broken materials of its composition. The margin of the crater, and of the other spiracles, was all in smoke,—the smoke was light-coloured *(silberweiss)*, and here and there a blue sulphur flame had penetrated to the surface. One side of the crater, which had fallen in, was filled with plates of red puzzolana. The cavity between the separated rocks was penetrated all over with spiracles, which continued in activity beneath the surface of the sea. Still more distinctly was seen the old lava near the level of the water, at the foot of the rock or peak, which rises in the form of an amphitheatre, and is, as it were, wrought into a terrace by steps and stairs *(stuffen und treppen)*. The margins of the beds, and of the hardened lava stream, of which these steps were formed, discovered wasting or weathering, from the constant action of the waves of this deep sea. They were of a brown-red colour, and porous.

These volcanoes are waste and uninhabited, and so naked, that not even a pile of grass grows upon them. Around *Oosi-*

ma flew, in crowds, a large grey species of *gull (MOEVEN)*; and in the deep, whales were spouting from their double blow-holes long streams of water into the air. *Maltebrun* (in his *Abridgment of Universal Geography*, vol. iii. p. 466.) says, "The town Matsmai lies on the south end of the island, and is discovered by a fortress, which cannot be approached from the land-side." I made a drawing of this town at no considerable distance, but I have seen no work of this kind, and the Japanese fortresses, in general, are not so frightsome and unapproachable as the European. "The other Japanese military forts," continues this author, "stretch from the west end to the north point of the island. In proceeding along the west coast, we come to the islands *Oosima*, *Coosima*, *Onosiri*, *Rioschiri*, (on which the Peak of *Langle* of La Perouse lies), and to *Rebunosiri*." Maltebrun knew the names of these two islands *Coosima* and *Oosima*, as well from Titsing's translation of the Japanese manuscripts respecting *Kannemon Zeroki*, or a description of the land of Jesso, or of the island of Matsmai,—as from the account of Krusenstern's voyage; but he knew not that these islands were volcanic, and, therefore, he says respecting Volcano Bay,—a circular basin abounding in picturesque views,—"that the name and every thing else seems to show that a volcano must exist here, yet have we not the slightest evidence of the actual existence of any such rock in this quarter." I have not, therefore, been unnecessarily engaged, in showing that not only do volcanoes exist in this sea, but that one of the smallest in the world may here be found;—a volcano which rears only its peak above the level of the waters; and which is especially worthy of attention, because the apertures, which take in and conduct the water of the sea into the interior chambers of the mountain, are placed not far from its summit,—because with one glance the whole mass of the volcano can be examined, and we can have under our eye the entire process of its kindling and explosion.

Nowhere in the world is it possible for a person to acquire a clearer or more distinct idea of the elevation of volcanoes, than in the course of the voyage from Kamskatka to Japan, through the Kurile islands, where most of the rocks and islands along which we pass, are active volcanoes, whose laboratories may here be seen in many different forms. The vast depth of the sea,—the far-sunk bases of the mountains, which rear their naked points or summits into the atmosphere,—their white hollow vents, through which the water of the sea flows,—the ceaseless decomposition of pyrites by the sea-water,—the release of the combustible air, which is a consequence of this decomposition,—and the neighbouring bituminous and other combustible bodies in the interior of the mountain which thus become inflamed,—all these appearances assist us in forming a satisfactory idea of the manner in which volcanoes are formed, which in this quarter may be observed in all stages of their formation and extinction, and of whose operation the black and burnt dross of the Kurile cliffs are an obvious testimony.

From these circumstances, there frequently happen explosions, gusts of wind, and the deposition of gravel with ashes, by which the voyager in these regions is often terrified. From the same cause, happen also the earthquakes which in this quarter of the world are so often experienced, and also the elevation and disappearance of islands,—which last often occurs merely from the subsiding of a crater which had projected above the surface of the deep, especially when the smoking volcano, in so far as it overtopped the waters, was only the bare peak or summit of a rock, whose base was at a great depth in the bottom of the ocean, as is at present the case with Coosima, of which we have been speaking.

It is hence, in my opinion, not unlikely, at least not impossible, that Coosima may again disappear, when its now smoking crater shall again subside. Krusenstern is not the first who has marked upon his charts both the islands Coosima and Oosima; they are also found in the charts of the discoveries of the Russians in the North-eastern Ocean, which the Imperial Institute, under the direction of the learned General of Engineers Count Von Suchtelen, published with annotations at St Petersburgh in the year 1802. They are here represented as lying right opposite to the Strait of *Sangar*, which is formed by Cape Sangar and Cape Nadeschda. On the N.NW. of Jesso or Matmai, there is a promontory, which, in the enlarged chart of the Russian discoveries, bears the name of Sinecko. From this promontory, which lies in 41° 38′ 30″ N. lat. and 220° 60′ 30′ W. long. there stretches a long chain of rocks right into the sea. It is likely that these rocks have a connection below water with a small island, which lies in the same direction with this chain of rocks from Cape Sinecko. The direction of the coast from Cape Nadeschda to Cape Sinecko is N.W., and the distance between these two promontories is eighteen miles. Between these, in an extensive and very exposed bay, lies the town Matza or Matsumai, which name the Japanese have also given to the whole island of Jesso. Although this town is of very moderate size, it is, however, the residence of the Japanese governor, and the only town upon the island. It is closely built of small houses, upon a high shore, after the Japanese fashion; the coast appears to divide itself on the right side, and to afford room to the embouchure of a river. Near the coast lay many Japanese ships at anchor, and more of them were lying in the docks. Many ships without the bay were employed in whale catching, in fishing, and in traffic. They always held their course along and very near to the coast. The want of a good harbour must, however, be a great hinderance to trade. The town Matza or Matzmai lies in 41° 32′ Lat. and 219° 56 W. Long. As the south coast of Jesso or Matmai lies so near the north coast of Japan, in so considerable a depth of water, Krusenstern believes, with some plausibility, that the two islands were formerly but one, and had been separated from each other by an earthquake; as it is understood that formerly in Europe there was much more connection between the different parts of this quarter of the globe; and that England was separated from France, Gibraltar from Africa, and Sicily from the continental land of Italy, only by earthquakes and volcanic explosions. But the separation of Jesso or of the island Matmai from Japan, is still more evident, 1*st*, From the number of still smoking or of lately extinguished volcanoes in this region; 2*d*, From the small breadth of the channel which separates Japan from Jesso; 3*d*, From the steepness of the banks on both sides, and the number and condition of the rocks: 4*th*, From the agreement between the colour and mass of the stones, which seem as it were to have been torn from one another, and from the similar direction of the equally elevated chains of rocks on both sides, which are separated only by this channel.

Krusenstern supposes, that this separation of Japan from Jesso, of which the probability deserves to be farther proved, by a careful examination of both sides of the coast, during some future voyage of European navigators through the Straits of Sangar, will be established and brought to the evidence of certainty. He even believes that this separation has taken place simply from the neighbourhood of the high Peak of Tilesius, and from its explosions. But the present construction of the rocky coast on both sides, with its conical-shaped summits, and pillar-shaped walls, which here and there are broken by fallen and shattered beds and layers of basalt-shaped materials, betrays so many traces of violent separation in the mass itself, and affords such distinct characters of a volcanic rock, that the cause of the separation may easily be found in the stone itself, and need not be sought for in the neighbouring volcanoes. When a person has seen the volcanoes of Kamskatka; those of Japan and the Kurile islands; those of the Marquesas or Mendoza islands, especially Nuckahuva; those of the islands of Teneriffe and St Helena,—with their volcanic construction, as we have seen them,—it is not difficult to recognise the volcanic construction of a group of rocks, even at some distance, and by the help of the telescope, and to become satisfied as to the general character of volcanoes which are without craters, or whose craters have fallen in, or which have become extinct. We must proceed, however, to a further consideration of the geographical position of the two volcanic islands Coosima and Oosima. The direction of both these islands is N.W. and S.E., and the channel between them is twenty miles in breadth. The western entrance into the Strait of Sangar cannot be missed, even when stormy weather might prevent our observation of the latitude. From the south, the first landmark that appears is the Peak Tilesius, which rises white above all the surrounding rocks, and which is distinctly pointed out by its height, and by its everlasting snows. Cape Greig, from which the direction of the coast to Cape Sangar is N.E. by N. nine miles, cannot be mistaken from its form and colour, which have been exactly given in our sea-views of the Krusenstern Atlas. But from the north, the islands Coosima and Oosima themselves are the most direct landmarks in the Strait of Sangar; Peak Tilesius and Cape Greig are here observable at the same time. Coosima lies directly over against the Strait of Sangar, and from this quarter the stream acquires additional strength, the nearer we approach the Strait. The south-west coast of Jesso, the town Matsumai, and Cape Nadeschda, cannot be mistaken, from the direction of the Krusenstern charts and the annexed sea-views.

Langsdorf, in his book respecting our navigation of the globe, mentions this rock as a land-mark, following no doubt the guidance of Krusenstern. As he also takes the assistance of Klaproth for a knowledge of the Chinese and Japanese dialects and geography, and Adelung as his master in literature and belles lettres; so we find here some etymological explanations respecting the names *Oosima*, *Coosima*, *Matmai*. *Oosima*, the name of the most westerly island, signifies in Japanese "the greater;" *Coosima*, the name of the other, signifies "the smaller island."—"*Matzumai*," says *Klaproth*, following probably the explanation of some Chinese writings, "is the name of the chief town of the whole island, and signifies the town of pines," (we, however, saw no pines.) But the island is not called Matmai by any nation. In Japanese it is called *Jesso;* and in the Chinese dialect *Chiazy*, which means *Crabs*. *Chia* are small sea-crabs, which, in German, are called *garnelen;* in Spanish, *lamarones;* and in English, *shrimps*. "Before the harbour of Matzumai lies the small island *Besaiten*" (this must be a very small island, for we did not see it), "which is reckoned sacred by the Japanese, and upon which they have built a temple. South-east from the town lies the most southern promontory of the island called *Sirra Kammisako*, and west from this, are two calm harbours for small vessels. Still farther to the east we meet with the harbour *Chakokade*, which is well known from the history of *Galoronius's* imprisonment among the Japanese, beside which some Japanese colonies lie; and not far from them, but more in the interior of the country, is the dwelling of the Kurile interpreter. On the whole south-

VIEWS OF THE VOLCANIC ROCK OF COO-SIMA

PLATE XI.

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Fig. 1.

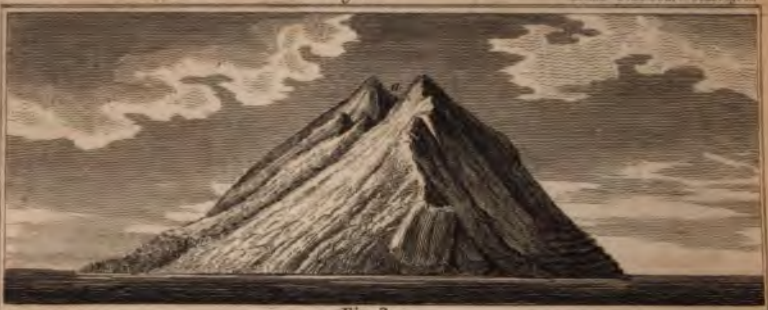


Fig. 2.

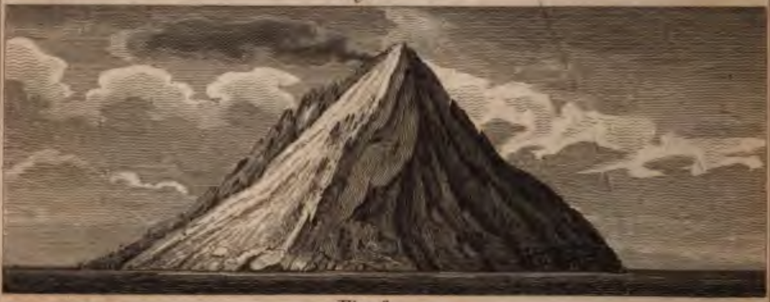


Fig. 3.

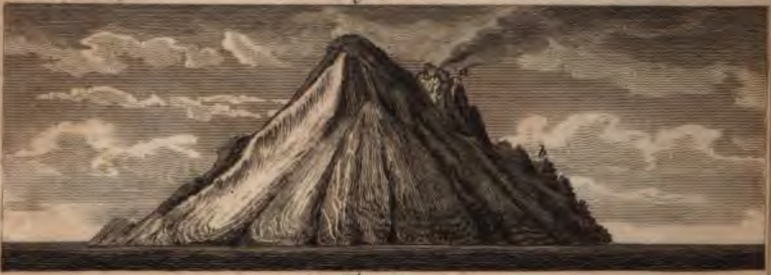
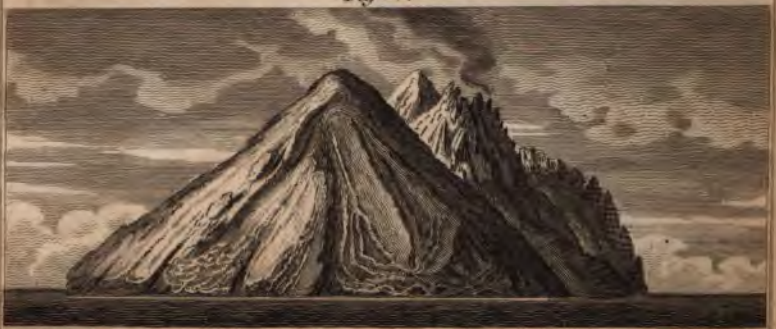


Fig. 4.



Dr. Tilesius ad. nat. Delt. W. H. Lizars Sculpt.

Edinburgh Published by A. Constable & Co. 1820.

west of the island there is abundance of sea-tangle (*sea-tang*, Fucus), which the Japanese call *combu*, and which they use for food."

Should this small contribution towards a more intimate acquaintance with the volcanoes in the Archipelago of Japan, obtain the approbation of geographers, I shall add some other sea views from Volcano Bay. I have considered the present to be especially worthy of being communicated, because, 1st, This volcano is probably the smallest in the world; 2d, Because it seldom happens that European sailors are permitted, by calms, to take advantage of the stream which flows round this rock; 3d, Because it is equally rare that any person can sail round the island, and so near to it, that all the objects on it can be distinctly discerned, and that it can be described and drawn from all sides; 4th, Because its small size presents it to us as a volcano *in embryo*, and secures to us so clear and complete a view of it, that we are in a situation to examine the construction and entire composition of the island; to look at its spiraculæ and cavities, which are opened to the entrance of the water, and thus to explain the elevation and formation of the volcano; and, 5th, Because the volcanoes of the Japanese Archipelago are not yet generally known, since Maltebrun, whom Krusenstern's illustrations of this part of Japan might have better instructed, mentions only the volcanoes of *Fico* and *Ficando*.

Explanation of Plate XI.

Fig. 1. This is a view of the rock Coosima, or the nearer island, seen at the distance of half a league from our ship, after its position, N. W. 70 by the needle, had been marked, on the 4th May 1805, at 10 o'clock A. M. It is here seen divided at the top. In the cavity between the parts we observed volcanic ashes; and, farther down, spiraculæ, and all the marks of lava having flowed.

Fig. 2. In this plate we have a nearer view of the rock, and see it undivided, or from the smaller size; it lies now more directly over against Matmai, W. 4°.27′. It was sketched on the 4th May, at 10^h 18^m A. M.

Fig. 3. In this view, the before-mentioned division of the summit again appears a little from one side. We here see also a fallen crater with white smoking margin, out of which blue sulphur flames ascend, filled in the middle with volcanic ashes; and near to, and below which, appear pointed basalt-shaped masses, and conical-shaped peaks, which *appear as if* formed by the neighbourhood or action of the sea-water. The rock lies here, according to the before-taken observation, S. W. 50°. From this side the greatest number of spiraculæ, and the deepest cavities through which the sea-water can force itself, are visible. Here also are seen the brown-red porous and wave-shaped margins of the layers and beds of dark coloured lava, lying upon one another, which seem to have been deposited in the shape of steps, and must have found their place at different times. This view was taken on the same day, at 10^{h} 37^{m} A. M., when the objects were seen with peculiar distinctness.

Fig. 4. In this view, the associated summits of the mountain appear. The rock is seen in its greatest latitude; according to the needle it lies S. W. 50° to 60°. First and nearest appear the two points of the mountain, which we saw in Fig. 1.; then comes the crater, which we saw sidewise in Fig. 3., and below it, and very near to it, the conical summits of the basalt-shaped masses, which apparently had been formed by the motion or approach of the lava, while in a liquid state, to the water of the sea, and of which there was a side view in Fig. 3., but which, from this view, appear to be the ruins of a fallen crater. We also discover in this view, by means of the wave-formed, brown-red, and weather-beaten margins of the naked layers of lava, the former periodical flowings of the lava, which lies in masses, like layers, upon one another, and seems to represent steps and stairs. This view of the mountain, according to which it lies in S. W. 50°, 60°, was taken an hour later, namely on the 4th May at 11^{h} 7^{m} A. M.

ART. XX.—*On the Volcanoes of Auvergne.* By CHARLES DAUBENY, M. D. M. G. S. In a Letter to Professor JAMESON.

DEAR SIR,

IN a late number of the Edinburgh Philosophical Journal, you expressed a wish that I would present to your readers some account of a Tour which I undertook last summer through certain districts in France, generally known by the name of Volcanic. Under ordinary circumstances, I might have felt much reluctance in coming before the public on such slender grounds, or in appearing to attach importance to observations which were necessarily of a desultory description; but, in the present instance, the absence of any printed account in our language, of a country which certainly yields to none in geological interest, and is constantly appealed to in all discussions which have reference to the supposed origin of rocks of the Trap Family, encourages me to comply with a request so flattering to my vanity, by offering an account of the Volcanic Rocks of Auvergne, which may be of some little assistance to future investigators, and which, if it does not satisfy curiosity, may at least contribute to excite it.

In stating, however, that no account of this country has appeared in the English language, I ought not to have forgotten "The Comparison of the Volcanic Rocks in France with those of a similar nature found in Scotland," for which the readers of this Journal are indebted to your pupil Dr Boué of Paris; a gentleman from whom I received myself much useful information, relative to the objects of the tour previous to my visit in Auvergne. As, however, the analogies he points out between the two classes of rocks cannot be fully understood by those who are strangers to either of the objects compared, I have derived from the perusal of his memoir, an additional motive for offering such a description of these rocks as may serve to supply this deficiency, and better enable your readers to determine in what degree the appearances there presented contribute to settle our belief as to the long-agitated question of the igneous or aqueous origin of trap-rocks in general.

These being the objects of my journey, you will not expect from me any attempt to lay down in a map the boundaries of the strata, or to determine with precision their geological relations.

Such an employment, indeed, seems to belong at all times rather to the native of the province, or at least of the country, who has frequent opportunities of repeating his observations at successive periods, than to the foreigner, who, with all the disadvantages of defective information, and want of familiarity with the language and manners of the people, devotes a few weeks to the examination of an extensive district. In the present instance, however, a Geological Survey of Auvergne (had it been practicable) was foreign to the object of my visit, which had chiefly in view the ascertaining whether there was such an analogy between the rocks of Auvergne and those in Scotland and the north of Ireland, which we usually find compared to them, as would oblige us to extend to the latter the same inferences which seem adopted by almost universal consent with regard to the former country.

I shall, therefore, begin by assuming, that the rocks which in Auvergne are found to occupy so large a surface, are the relics of volcanoes, and that there is among them such a distinction of character as leads us necessarily to infer that they are of very different dates, and may be distinguished by the names of Ancient and Modern.

If there be any of your readers that object to this division, as founded upon theoretical considerations, it may be replied, that there is that marked difference in character between the rocks which we refer to the one or other of these classes, as perfectly warrants our placing them under different heads; and therefore, that such as do not agree in their interpretation of the facts, may still follow us in the order in which we arrange them.

Now, the volcanic rocks which we have chosen to distinguish as above, are known by this important circumstance: The ancient like rocks of Neptunian origin in general, are cut through by the valleys which now exist; whilst the modern follow exactly the inequalities of the ground, so as to afford the most convincing proof, that the strata in which they rest have experienced no important alteration since the period at which the lava was ejected.

Nor are the two classes of rocks less distinguished in their external characters than in their position. The modern, or, more correctly speaking, the post-diluvian lavas, are more cellular, have a harsher feel, and more of a semi-vitreous aspect; their surface presenting a series of minute elevations and depressions, and the scanty portion of soil which covers them affording but little pasturage, and that generally of the worst description.

In short, when we traverse the streams of lava which have flown from this order of volcanoes, we imagine ourselves transported into the neighbourhood of Etna or Vesuvius, and ask ourselves for the records which must, it should seem, have handed down to the present age the memory of catastrophes, the date of which appears so recent.

These records, nevertheless, are nowhere to be found, and the evidence we are in quest of, can only be collected from the volume of Nature, which, in this instance, speaks a language so intelligible; for, with regard to the popular names of certain of the mountains and valleys to which some have referred as indications of a remote tradition, it seems more probable, that they were applied to the places which they designate, in consequence of the ideas which their appearances were calculated to suggest to the minds of their first inhabitants, than from the latter having been themselves witnesses of the events which occasioned them.

The high antiquity of the most modern of these volcanoes is indeed sufficiently obvious. Had any of them been in a state of activity in the age of Julius Cæsar, that general, who encamped upon the plains of Auvergne, and laid siege to its principal city *, could hardly have failed to notice them. Had there been even any record of their existence in the time of Pliny or Sidonius Apollinaris, the one would scarcely have omitted to make mention of it in his Natural History, nor the other to introduce some allusion to it among his descriptions of this his native province; and yet if my friend Professor Buckland be correct, in attributing the excavation of our valleys to the Mosaic deluge,

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* Gergovia. *Vide* Cæsar's Com. Lib. 7.

the modern volcanoes of Auvergne must all have been posterior to the latter event.

Another important characteristic of the modern volcanoes, of frequent, though not of universal occurrence, is the existence in them of craters. That of the Puy Pariou, near Clermont, is as perfect as any of those belonging to volcanoes now in activity; others, though less complete, retain sufficient indications of their origin; whilst a third class might perhaps be hardly known as such, unless viewed in connection with those contiguous.

Such are the principal circumstances which mark the first order of volcanoes; the characters of the second we shall defer, until we come to describe the mountains in which they are principally found, proceeding at present to some details respecting the rocks in the neighbourhood of Clermont, where the modern class of volcanoes are chiefly, though not exclusively found.

MODERN VOLCANOES.

The town of Clermont, the capital of the ci-devant province of Auvergne, and of the present department of the Puy de Dôme, is situated in the plain of Limagné, one of the most fertile I believe in France. The peculiar richness of the soil may perhaps be attributed to the character of the substratum, composed of an alternation of calcareous and sandy beds, which are referred to the same formation with those which cover the chalk near Paris; and in our own country in the neighbourhood of London and the Isle of Wight.

The extensive distribution of these beds in the valleys throughout France, might afford an excellent field for the scientific traveller; but it would be foreign to the present purpose to enter further into their detail, as we may have something to say respecting them when speaking of the neighbourhood of Aurillac in Cantal, where they likewise occur. These beds are deposited in a granite bason, which constitutes the hills bounding either side of the plain of Limagné, and rises particularly in a striking manner to the north-west of Clermont, where it forms the chain of hills on the road to Limoges, seen so conspicuously from the town, and on which repose the volcanic rocks which it will be our object to describe.

The recent limestone beds already noticed, merely cover the granite in the bottom and on the sides of the valleys, attaining only the comparatively moderate elevation of the hill Gergovia, where they are capped with basalt; but not seen as we ascend the loftier mountains to the N. W. of Clermont, where the fundamental granite, wherever it is concealed, is covered by a description of rocks of quite a different character.

These rocks constitute a chain of eminences which rise considerably above the elevated granitic platform on which they rest, and extend at intervals over a space of above eight leagues from north to south; from whence the rocks which compose them may often be traced a considerable way into the valleys contiguous. Above sixty of these eminences might, I believe, be enumerated within the boundary marked out; but as their number renders selection necessary, we shall simply notice such as are most remarkable, beginning with that of Volvic near Riom,—the lava of which furnishes a considerable part of the building-stone used in that neighbourhood, and, in spite of its porous character, is exceedingly durable*.

The lava which covers the valley of Volvic, extending nearly to the town of Riom, may be traced up the sides, and to the summit of the Puy de la Nugere to the west of it, whilst not a vestige is to be seen at a similar elevation on any of the hills to the east. The fact, therefore, of its having descended in a liquid form from above the mountain, and that at a period subsequent to that of any of the great revolutions which have changed the face of our planet, is demonstrated by the exactness with which the stream of lava has accommodated its course to the slope of the valley; and that its fluidity was owing to heat, is evident enough from its porous texture and semi-vitreous aspect; so that its connexion with volcanoes now in activity seems sufficiently apparent.

On the summit of the Puy de Nugere, is a regular bason-shaped concavity, broken away on the side, down which the lava has taken its course, and notwithstanding the changes which time has effected in its form, still retaining sufficient marks of having been once the crater, from whence the lava of Voloic was ejected. It is interesting to remark, that the stream in its descent appears to have been arrested by a sort of knoll of granite, which probably rose considerably above the general level, and by the obstacle which it opposed to its progress, caused it to divide into two branches, between which this little granitic eminence still is seen protruding,—a solitary vestige of the stratum which formerly existed on the surface, but it is now overspread with lava. The two branches of the main stream appear to have become reunited below; and having descended the slope of the hill, to have spread themselves over the valley of Volvic, extending over it to within a mile perhaps of the town of Riom.

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* Its dark and sombre character adds much to the religious gloom of the Cathedral of Clermont.

The only remarkable mineral found among the lava of Volvic is specular iron-ore, or *fer oligiste* of the French School. It occurs in the crevices of the rock, as well as disseminated through its porous structure in minute plates of a bright metallic lustre. It is met with also in the Puy de la Vache, the Puy de Dôme, and among the trachytes of Mount Dor; and the same mineral is a well known product of volcanoes now in activity, where it is generally considered to be the effect of sublimation. The lava of the Puy de Côme, a mountain a few miles to the north-west of Clermont, which I unluckily omitted to examine, is described by M. Mont Losier, the author of a little Essay on the Theory of the Volcanoes of Auvergne, is equally interesting with that of Volvic. The lava that has flown from this hill divides, he says, into two branches, one of which flows directly into the bed of the River Sioule, whilst the other takes the direction of a place called Tournelise, reaches the village of Pont Gibaud, and terminates, like the other, by flowing into the bed of the same river, about three miles lower down. A torrent of this description might naturally be expected to effect singular changes in the face of the country which it traverses.

Accordingly we shall find that it has blocked up a little valley which formerly seems to have had a drainage to the west, on the side of Chambois and Massanges, and has converted it into a sort of swamp, known by the imposing name of Lac de Côme. Lower down, the same stream of lava has occasioned still greater changes. The rivers Sioule and Menges formerly ran parallel to each other, in a direction from north to south, and entered the plain of Pont Gibaud by two defiles, separated by the intervention of two hills. But one branch of the lava of Côme has so obstructed the course of the river Menges, that the waters have been directed to the east, where they have worked themselves a passage through an argillaceous hill; made immense excavations in it, and have thus reached the bed of the river Sioule, a league and a half higher up than they would naturally have done. Compelled, however, to flow in a direction contrary to the slope of the country, a large portion of the waters constantly stagnates in its channel, and has formed a swamp, which goes by the name of the "Etang de Fung." A portion only of the stream flows by the original outlet, which, it seems, was not completely obstructed by the torrent of lava. The rest accumulates in the pool of Fung, until the waters have risen to a height sufficient to drain off by the channel, communicating with the river Sioule, which they have made themselves to the east.

A somewhat similar circumstance has happened to the Lake Aidat, which is obstructed by a stream of lava, that may be traced from the Puy de la Vache, a mountain at least a league distant.

In this case, however, a still greater impediment existing to the escape of the waters by any other outlet, the obstacle has merely had the effect of raising the level of the lake, which has at length succeeded in cutting itself channels through the parapet of lava thrown across it, the projecting portions of which appear like islands in the midst.

With reference, however, to the more immediate objects of my inquiry, I know of none of the hills in the neighbourhood of Clermont which interested me more than the Puy Graveneire. This mountain, which lies within two miles of Clermont, seems, as we approach its summit, to consist of an entire mass of cinders *, so that we may in some degree comprehend the origin of the ludicrous opinion ascribed to a professor of the Academy of Clermont, when the volcanic nature of the

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* In descending it, however, to the west, we find that the rock subjacent is granite, which exhibits marks of dislocation.

rocks of Auvergne was first asserted and maintained, by an appeal to the structure of this particular mountain, who it is said accounted for the scoriæ found on its surface, by gravely remarking that he had heard of iron-founderies having formerly been established on the spot. As we follow, however, what may be considered as the stream of lava derived from this mountain, by descending it on the side nearest Clermont, we observe the scoriaceous lava before described, associated with a basaltic rock of the most compact character, and approaching to a metallic appearance. It has imbedded fine crystals of augite and olivine, and bears in all respects a very strong resemblance to the rock of Arthur's Seat, and some other of the Scotch basalts.

If any doubts should arise as to the circumstances of two such different substances belonging to the same current, they will be removed when I remark that both are so intermixed, that portions of the scoriaceous are often seen in the midst of the compact lava; and masses of the latter surrounded by heaps of cinders, or with a cellular rock, which, both in composition and external characters, passes by imperceptible gradations into basalt. The association of a substance like this with undisputed lava, should render us cautious how we pronounce as to the origin of a rock from its external characters. If all basalts, to which an igneous origin is ascribed, owed their compactness to the pressure they underwent, how is it that we see this very rock connected with a lava remarkable for its porous texture and vitreous appearance? Or if we suppose pressure to have been in this instance applied to the compact variety, by what singular accident could the cellular lava have escaped that to which the other was subjected?

I mention these facts, rather with a view of inviting inquiry than of drawing any conclusion from them; as in the case of the basalts and cellular lavas of Mont Dor, of which we shall afterwards speak, the position of the rocks was such, as tended to confirm us in the idea of the difference in the two instances having resulte [illegible] the degree of pressure, it is possible that those who [illegible] r me may, by a more attentive examination of [illegible] neire, discover the reason for this apparent ex [illegible] ntly with the received notions on the subject. [illegible] me, I must remark, that the

PLATE XII.

Fig. 1.

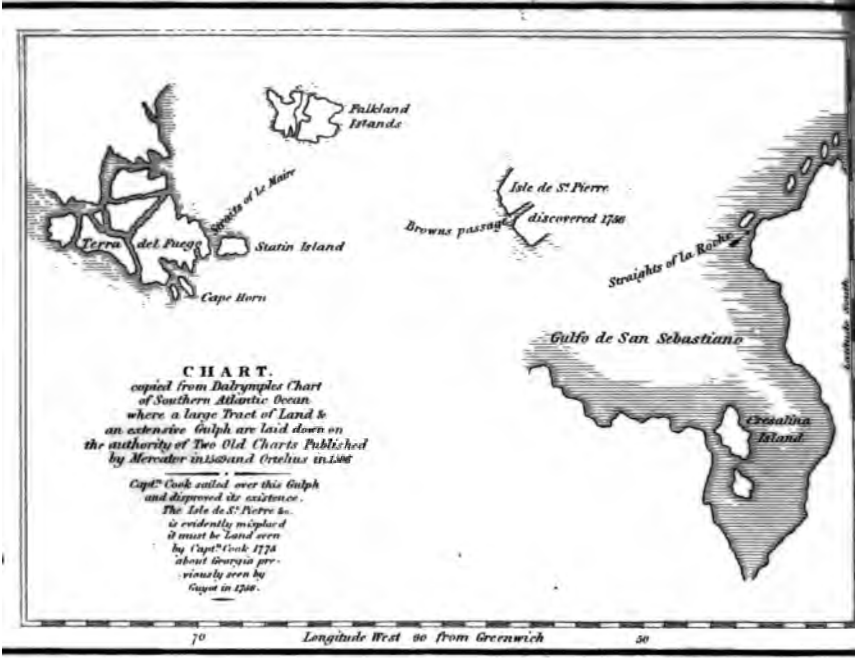
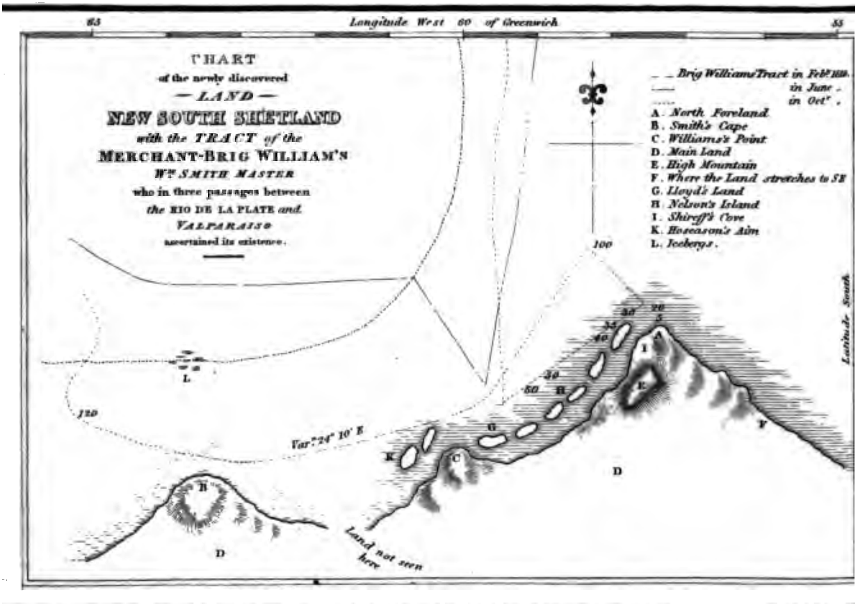

Falkland Islands
Terra del Fuego
Straits of Le Maire
Statin Island
Cape Horn
Isle de St. Pierre
discovered 1756
Browns passage
Straights of La Roche
Gulfo de San Sebastiano
Cresalina Island
Latitude South
CHART.
copied from Dalrymples Chart
of Southern Atlantic Ocean
where a large Tract of Land &
an extensive Gulph are laid down on
the authority of Two Old Charts Published
by Mercator in 1569 and Ortelius in 1586
Captn. Cook sailed over this Gulph
and disproved its existence.
The Isle de St. Pierre &c.
is evidently misplaced
it must be Land seen
by Captn. Cook 1775
about Georgia pre-
viously seen by
Guyot in 1756.
70
Longitude West 60 from Greenwich
50

Fig. 2.



Engd. by W.H.Li

Edinburgh, Published by A. Constable & Co. 1820.

Puy Graveneire was not the only instance that occurred to me in Auvergne, of a basalt agreeing in character with those of Scotland being associated with a rock possessing a vesicular structure, and that I have at present in my possession more than one specimen which places this matter beyond doubt.

The Puy Graveneire is also remarkable, inasmuch as, notwithstanding the strong indications it presents of having been in a state of ignition at a comparatively recent era, no trace of its crater can be detected, nor has it that abrupt and conical form so characteristic of volcanic hills, being rather a long, round-backed eminence, rising abruptly indeed on two of its sides, but to the north connected with the chain of the Puy de Dôme, and to the south gradually sinking into the plain of Clermont.

(To be concluded in our next.)

ART. XXI.—*Account of the Discovery of New South Shetland, with observations on its importance in a Geographical, Commercial, and Political point of view: with two* PLATES*. By Mr J. MIERS. Communicated by Mr HODGSKIN.

DURING my last visit to Santiago, to convey A—— and Lady C—— to Valparaiso, I employed my first leisure hours in drawing up the following paper. I shall introduce the detail in regular order, previously hinting my opinion that a large Southern Continent is about to be discovered. The existence of this continent was believed many ages since; the ancient, and many modern philosophers being fully convinced that a vast tract of land must lie within the limits of the Antarctic Circle, to which they gave the name of Terra Australis Incognita. Many were the speculations of the ingenious on this subject, but perhaps none were more highly pictured in imaginative colours than those of Maupertuis (in his Letter to the King of Prussia), who pourtrayed a continent far larger than any of those known to us, where the inhabitants, animals, vegetables, indeed the natural productions of every description, differed from all others yet known; and also where objects for commercial traffic might be found that would exceed all the treasures of the known world. Buffon, De Brosses, Campbell, and many others whose works, at this distance from the seats of knowledge, I am unable to consult, treated the subject in lively colours; some even went so far, as to calculate the superficies of this supposed continent at 8 or 10,000,000 square leagues; an extent of territory equal to the amount of all the continents and territorial possessions yet discovered. These speculations led to expeditions of diligent enterprise; but the attempts of the most celebrated navigators, at the head of whom Captain James Cook stands most eminently distinguished for his persevering and bold efforts to determine the question, entirely failed; and all hopes were long since given up of ever being able to ascertain the truth of the old favourite notion of a Southern Thule. Captain Cook, from many reasons, detailed particularly in his description of Sandwich Land, which he conceives might be part of this supposed large continent, says *, " if any one should have resolution and perseverance enough to clear up this point, by proceeding farther to the south than I have done, I shall not envy him the honour of the discovery, but I will be bold to say that the world will not be benefited by it."

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* See Plates XII. and XIII.

He was led to form this conclusion from the intensity of the everlasting frost; the apparent absolute barrenness of Sandwich Land, which lies in latitude 58° south; the dangerous navigation, and the abundance of ice islands about it, erroneously concluding that all land placed in a similar southern latitude must be equally inclement and unapproachable. All hopes of discovery have therefore long since been abandoned, and it will excite no little surprise to hear that a large tract of *apparently habitable land* has been ascertained *to exist to the southward of Cape Horn*, by the captain of a British merchant brig, trading between the Rio de la Plata and Chili, who has displayed a spirit of enterprise that would do honour to a more enlightened navigator.

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* Cook's *Second Voyage*, p. 243.

Independent of any national consideration, the result of this inquiry will clear up an important question in hydrographical and geographical science.

Mr William Smith, master of the brig Williams of Blythe, in a voyage from Buenos Ayres to Valparaiso, fancying that the passage round Cape Horn might be weathered better by preserving a more than usual southerly course, being on the 19th of February 1819 in Lat. 62° 40′ south, and Long. 60° W. imagined he saw land at the distance of 2 leagues; at that time he observed many fields of ice floating about, but so distinctly different was the appearance alluded to, that he was convinced it must be land. At this time, encountering hard gales of wind, accompanied by flying showers of snow, he thought it prudent to haul off to the northward during the night. Next day (February 20.) he again stood in for his supposed land; at noon his Latitude by observation was 62° 17′ S., Long. 60° 12′ W. by an excellent chronometer; the weather was moderate, and the atmosphere clear, when he again made the land. So fine was it, that he could not mistake the appearance. Fearing the return of blowing weather, he was deterred from approaching nearer, and being principal owner of the brig, he was unwilling to endanger the validity of his policy of insurance, in case of meeting with any accident in his research. He observed, however, to the westward more land, which he approached to the distance of 10 miles; this, as well as the former, appeared to be an island; both at this time offered the appearance of snow only in very few places: and were almost wholly bare, barren and rocky. The air felt pleasant and temperate, with a fine clear atmosphere, and agreeable sunshine: he observed great abundance of whales and seals. In such a responsible situation with regard to his ship and cargo, he contented himself with this distant survey, and on his arrival at Valparaiso, he related every thing that he had seen to the English there, who all ridiculed the poor man for his fanciful credulity and his deceptive vision; no one, in fact, gave the least credit to his tale, all endeavouring to persuade him that what he had seen was no more than ice-islands. Mr Smith was not, however, to be thus easily laughed out of his own observation; he is a native of Blythe in Northumberland, had been brought up in the Greenland whale-fishery; and had learned to distinguish land from icebergs; though it must be confessed that the most experienced eye is often deceived by the striking similarity. If I mistake not, I informed you thus far of the discovery, in a letter I wrote you soon after my arrival in this country. What I then learned of it was from a young man, who took his passage during this voyage. Mr Smith on his return to the River Plate in June following, was determined, if possible, to verify what he had seen: he steered in the latitude of 62° 12′ S., but when he reached the longitude of 67° W. he became so beset with loose pack-ice, that he was alarmed for the safety of his ship and cargo; in a few hours he got clear, and stood off on his course, considering that all attempts in his situation, with the very short days and in the depth of winter, would be extremely indiscreet.

On his arrival at Monte Video, he was again ridiculed for his credulity: his confidence in the observations he had made was certainly shaken; but he could never be led entirely to renounce his former conclusions. On this occasion, Mr Smith conducted himself in a manner becoming an Englishman: His account reached the ears of some American merchants, who endeavoured to obtain from him the true situation of the land; they offered to charter his ship on a voyage of discovery, and to employ it in whaling, making that the apparent object of the enterprize. Copies of articles were drawn up. The Americans now endeavoured to ascertain from him the longitude and latitude of the land; but he, to his credit, refused to disclose it to any but a British born subject: he honourably offered to conduct the vessel there, and, if no land existed, to receive no freight; but that was not the object of the other party: Thus defeated in their manœuvre, the Americans withdrew their contract, and the honest Englishman determined to run the chance of waiting many months for employment of his vessel. At length, having obtained freight a second time to Chili, he set off on his voyage, and on the 15th of October last, at 6 P. M. being then about the same latitude and longitude as before, he discovered the same land, bearing S. E. by E. 3 leagues. The weather was hazy: he bore up for it, and approached within 4 miles of it, when he proved it to be an island, or rather a large barren rock, inhabited only by innumerable penguins: he sounded, and in 40 fathoms found a bottom of fine black sand: he hauled in for the same island, till it bore E. by S.; having sounded when in 60 fathoms, he procured the same bottom of black sand. During the night, he hauled off for security to the northward, but at day-light next morning he again stood in for the island: he could now distinguish it perfectly at the distance of 3 leagues; he sounded in 95 fathoms, and brought up fine sand and ooze. At 8 A. M. the weather being very clear, he could plainly distinguish the mainland, bearing S. S. E., the island being distant from it about 3 leagues. The mainland presented itself as a cape, to which the coast tended in a N. E. direction, having peculiar marks, of which he took rough sketches: he stood in, and ran along the land as far as the point, to which he gave the name of North Foreland, A, Pl. XII. Fig. 2. obtaining all the way regular soundings of sand and gravel, lessening gradually from 35 to 20 fathoms; the bottom was good and regular. He now hauled in for the cape, and proceeded, within 3 leagues, more easterly; the island now bearing N. W., distance 7 leagues, and observing the appearance of a good harbour, he sent a boat's crew and his first mate on shore, where they planted a board with the Union-jack, and an appropriate inscription, with three cheers, taking possession in the name of the King of Great Britain. To the mainland was given at first the name of New South Britain; but as that title, it was suggested, might lead to confusion with other places, Mr Smith changed its name to *New South Shetland*, on account of its lying in about the same latitude as the Shetland Islands. The coast here was barren and rocky, and from the description I could obtain from the mate, I should suspect it to be chlorite-slate or schistose hornblende. The land was high, disposed in strata, offering projecting knots, dipping westerly, the highest points being covered with snow, particularly the peak of a very lofty hill marked E. in the chart, remarkable for a large black spot mid-way up the snowy height. At the place of landing the spot was barren, being stony, not of rounded pebbles, but of bluish-grey slaty pieces, varying in size from very large to very small. The harbour appeared to proceed inland as far as the eye could reach; and to afford a good anchorage. The place I, in the chart, he called Shireff's Cape, in honour of the Commanding Officer in the Pacific. The day drawing to a close, the boat pushed off, the master, with the usual prudent views, hauling off the shore with his ship. The harbour appeared to abound with the real spermaceti whale, Physeter macrocephalus, which he says exists there in greater abundance than he imagines has ever been elsewhere known: that it was the real spermaceti whale he is certain, having himself been brought up in the whale-fishery. Seals and sea-otters abounded, as also an animal differing from the sea-otter, which I imagine may prove to be a variety of the ornithorynchus. He continued to haul off during the night to the northward, to such a distance that he could just keep the cape in sight to the southward. Next morning at day-break, he could perceive the land marked F in the chart, trend in a S. E. direction. At 11 A. M. the Foreland bore S. E. by E. 5 leagues distant. Keeping his course to southward and westward, still preserving the mainland in view, the several other islands called Nelson's Isles, H, all appeared to be distant from it about 3 leagues. The islands were all alike barren and rocky. To one of the largest, marked G in the chart, he gave the name of Lloyd's Island; the mainland, however, was very considerably higher. The wind changing to the eastward, attended with thick squalls of snow, he thought it prudent (always having the safety of his cargo as his primary consideration) to haul off. The weather moderating, he made the point of land which he called Cape Williams, C; at that time the atmosphere was quite clear, and with a telescope he could most distinctly perceive trees, which bore the resemblance of Norway pine, and which seemed to grow to a tolerable height: Indeed, he describes the whole appearance of the land, the structure and shape of the hills, the quantity of snow, the appearance and quantity of ice about the coast, as being more like the Norwegian coast than any land he ever saw. His course hence was S. W., but the weather becoming thick and squally, he began to abandon all thoughts of exploring the coast farther. He had now clearly ascertained the existence and situation of the land for the length of 150 miles in a W. S. W. direction so satisfactorily, as to remove the doubts of the most sceptical; and considering that no curiosity could justify his farther delay, consistently with his duty as master of the brig, he shaped his course westerly on his voyage.

The weather at daybreak next day becoming more settled, he was surprised at descrying another headland, B, far higher than any yet seen bearing E. N. E. distance 10 leagues. This point he named Smith's Cape: and the weather being remarkably clear and fine, he proved it by observation to lie in latitude 62° 53′S.; longitude 63° 40′ W. From Smith's Cape, the land appeared to extend in a south-westerly direction; but however eager he was to prosecute his search, he concluded that he had fully attained his object, having proved the existence of the coast for the distance of 250 miles. He therefore shaped his course to the northward; and in the month of November reached the Port of Valparaiso, having delayed the vessel six weeks on the voyage, for the mere purpose of prosecuting this interesting object of pursuit. I have omitted to mention, that during a visit on shore at Shireff's Cove, independent of penguins and various sea-fowls, abundance of wild land fowls and fresh water ducks were observed, which were so little shy, that they could be approached very close before they would stir. The existence of these birds augurs well for the adaptation of the place for the habitation of man. The harbour, too, offered an excellent anchorage: it was well protected in all points, but one very small angle,—the island affording a good shelter to the mouth; from this cause, there appeared but very little surf, and the shore seemed very bold. One may judge of the sensation produced in the breast of an Englishman on hearing the relation of Mr Smith; every one became struck with the advantages which a British settlement would offer, not only to our whalefisheries, but to our commercial interests in this part of the globe. Until the political arrangements of these countries (the Spanish colonies) become in some degree settled, the consequences resulting from the animosities that may possibly arise between the many contending parties must necessarily be feared. Those who were here during the affair at Cancharayada, well know the value of any thing like a British settlement, however miserable, to retire to. On the arrival of the Williams in November last, there was a general and simultaneous feeling among the English merchants, who instantly set about taking up a vessel, which should be chartered on a voyage of discovery at their own expence. Mr Smith, on his arrival, having transmitted his observations to the commanding officer in the Pacific, Captain Shireff of the Andromache, who was at that time in Santiago, concluding diplomatic arrangements with the Government, prior to his visit to the north-west coast of America,—this excellent officer, ever alive as well to British interests as to the pursuit of objects of science and utility, instantly chartered the same brig Williams on Government account, in order to make an accurate and regular survey of the coasts and harbours, and to ascertain the advantages it might offer to our whalefisheries. So prompt were his measures, that although the vessel was loading to convey my goods to Concan Bay, the moment of his arrival in the port the bargain was concluded. Every article of mine was again transhipped. The Williams was refitted completely with every necessary for the voyage,—and in one week put to sea, being placed under the charge of Mr Edward Bransfield, master of the Andromache, who had under his orders Mr Bone, Mr Blake, and Mr Poynter, three midshipmen of the Andromache, and Mr Young, assistant-surgeon of the Slaney sloop of war. Mr Bone, son of the celebrated enameller, is a good draughtsman. They were all ordered to observe, collect and preserve, every object of natural science, during the prosecution of the more important objects of the expedition. The Williams got under weigh and quitted Valparaiso on the 19th December, the same day the Andromache left the port for Callao.

It was at first stated by many captains of vessels lying in this harbour, that the discovery of this land was not new;—that it was laid down in several old charts. These I examined, but found in all cases that they were copied from Mr Dalrymple's chart, published in 1770, (See Plate XII. Fig. 1.) in which an extensive tract of country is placed between the latitudes of 54° and 58° S., and of longitude 40° and 53° W. having a large gulf, called Golfo de San Sebastiano. This land was first laid down in a chart published by Mercator in 1569, and subsequently in another by Ortelius in 1586. Its existence was doubted by many, and Captain Furneaux (the coadjutor of the celebrated Captain Cook) visited in 1774, in the Adventure, that tract of the globe, for the purpose of verifying or disproving its existence. He passed over both the western and eastern shores of the Gulf laid down as above mentioned, his tract being,

61° 45′	S. Lat. -	89°	W. Long.
61 49	- - -	84 1′	- -
61 20	- - -	71 50	- -
60 34	- - -	57 43	- -
60 20	- - -	53 20	- -
60 2	- - -	48 25	- -

But he could neither discover the least indication of land, nor could he obtain any bottom soundings.

"It was proved, therefore," says Dr Forster in his account of the voyage, "that this gulf (and of course the encircling land) does not exist, or that it is not rightly laid down in former charts, and the latter is much more probable, since it can hardly be conceived by what means such a discovery could obtain a place in the old charts."

Captain Cook, next year in the Resolution, sailed over the same tract with similar views, "to ascertain the existence of San Sebastian's Gulf, and the extensive tract of coast laid down in Dalrymple's chart." Leaving Staten's land, he passed to

57° 21′	S. Lat.	57° 45′	W. Long.
58° 9′	- -	53° 14′	- -

which is the point assigned by Dalrymple as the S. W. point of the Gulf; but fearing he might miss the land said to have been discovered by Duclos Gayat, in the ship Lyon in 1756, which Dalrymple places in 54° 30′ lat. S. and 45° long. W., yet laid down in D'Anville's chart 9° or 10° more to the westward, he hauled to the north, and passed to

56° 4′ S. Lat. 53° 36′ W. Long.

where he sounded in 130 fathoms, without finding any bottom; hence to

55° 4′	S. Lat. -	51° 45′	W. Long.
55 12	- - -	50 15	- -
54 35	- - -	47 56	- -
54 38	- - -	45 10	- -
54 28	- - -	42 8	- -

which is 3° to the eastward of the N. E. point of the Gulf, as assigned in the charts. His track then was to

55° 7′ S. Lat.	W. Long.
53° 56′ - -	39° 24′ - -

where he found a muddy bottom in 175 fathoms: hence he arrived at Willis's Island and Georgia.

In latitude 60° S. and long. 31° W. Captain Cook met with a heavy swell from the westward, "a strong indication," says he, "that there was no land in that direction; so that I think I may venture to assert, that the extensive coast laid down in Dalrymple's chart of the ocean between Africa and America, and the Gulf of San Sebastian, does not exist."

It is difficult to conceive how so extensive a tract could obtain a place in the old charts, unless some authority had been offered for it. We are, however, ignorant of the authority, though, from the name of the Golfo de San Sebastiano, it may be presumed to have originated in the accounts of the Spaniards. The particular formation of the land,—the existence of an island within the Gulf, called La Isla de Cressalina,—offer additional reasons for believing it had been seen. These considerations led Dr Forster, who in the Adventure had satisfactorily disproved its existence, as laid down in the charts, to draw a similar conclusion. He adds, "I am inclined to believe that Sandwich Land has been discovered by those early navigators, who furnished the geographers with the Gulf of San Sebastian, and the Island of Cressalina,"—an observation now more applicable to the land seen by Mr Smith. In support of this opinion, it is worthy of remark, that the shape of the land, as described by Smith, bears a striking resemblance to that tract of coast laid down in the old charts. The islands in the latter bearing the same situation in regard to the mainland as Smith's and Nelson's Isles, the direction of the coast of the mainland bearing as well a W. S. W. direction in both instances; the headlands, too, of the old charts, strongly resembling the North Foreland, Williams's and Smith's Capes. The existence of a gulf in New Shetland, similar to that of San Sebastian, is yet undetermined: it is, however, to be remarked, that Smith could not observe the land in the same relative situation, the weather being at that time extremely hazy,—indeed he had concluded that he had lost sight of the land altogether. Should a gulf be hereafter ascertained to exist there, it would place it beyond doubt that this newly discovered land has been before noticed by the earliest navigators of those parts, but incorrectly laid down in the old charts. However this may be, it would seem that this land was seen subsequently to the dates both of Mercator's and Ortelius's charts, by a Dutch captain; but the exertions of our indefatigable circumnavigators, had taught us to place little reliance upon the accounts of the old navigators. In the present instance, however, we have this circumstance in its favour, that it is stated to exist in about the same latitude as laid down by Smith *.

" Theodore Gerrards, one of the first Dutch who attempted to voyage into the South Sea, after passing the Straits of Magalhaens, being carried by tempests into 64° of south latitude, says the country was mountainous, and covered with snow, looking like Norway, and seemed to extend to the islands of Salomon,"—that is to the Cape of New Holland.

It is also worthy of remark, that the observation of Mr Smith, of the great similarity in the appearance of the land to Norway, exactly coincides with the observations of Gerrards.

As yet it remains an interesting topic of conversation, whether New Shetland be an island of considerable size, or if it be part of a continent. It is by no means an improbable supposition that it is connected with Southern Thule, the most southerly point of Sandwich Land seen by Captain Cook in 1775, and situated in 59° 30′ lat. S., and 27° 30′ W. long. The observations of Captain Cook seem to favour this conclusion. He says: " I conclude that Sandwich Land is either a group of islands, or else a point of a continent; for I firmly believe that there is a tract of land toward the Pole, which is the source of the ice spread over this vast ocean. I think it also probable, that it extends farther to the north, opposite to the Southern Atlantic and Indian Oceans, because ice was always found by

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* See Dalrymple's Collection of Voyages to the Southern Atlantic and Pacific, vol. i. I could not obtain the 2d volume, where I believe he has collected some other authorities in proof of land having been seen to the south.

us farther to the north in these oceans than any where else, which I judge could not be, if there were not land to the south; I mean a land of considerable extent." About the longitude of 27° W., Cape Montagio, the most northerly point of Sandwich Land, lies in the latitude of 58° 25′, and icebergs are found hereabout in the latitude of 48°. In the longitude of 57° 30′, North Foreland, the most northerly point of New Shetland exists in the latitude of 62°; and in the longitude of 67° W. the same land appears to fall off to the latitude of 64° S. Fewer icebergs are met with still more to the westward; for noticing the Adventure's track in 1774, it was observed, that in longitude 106° 54′ W. icebergs were not met with till the latitude of 71° 10′ S. In long. W. 142° 54′, he was beset with icebergs in the latitude of 67° 31′ S., and in long. 172° W. he found them numerous in the latitude of 62° 10′ S. Cook remarks, that between the meridians of 40° W. and 60° E. ice is invariably encountered in the latitude of 51° S. Modern researches have proved that icebergs always derive their origin from adjacent land. Between the meridians of 40° and 60° W. icebergs are invariably encountered in a somewhat lower latitude, from which we may infer, that land exists along one continued tract to the southward within these meridians, and it is by no means unfair to conclude, that New South Shetland and Sandwich Land form two points of one large continent.

There exists, too, some similarity between the appearance of Sandwich Land and South Shetland. "Approaching the former," says Dr Forster, "within half a mile, the rocks were black, cavernous, and perpendicular to a vast height; thick clouds veiled the upper parts of the mountains," &c. Hence, proceeding to Southern Thule, "the mountains appeared to be of vast height, their summits being constantly wrapped in clouds, and the lower part covered with snow down to the water's edge, so that it would have been difficult to pronounce whether we saw land or ice, if some hollow rocks had not shewn their black and naked caverns in several places." Precisely similar were the appearances of the mountains of the North Foreland in South Shetland, where the uninterrupted white surfaces of the higher hills were in parts broken by black spots: one very large one on the high peak of land marked E in the chart, was probably the effect of a cavern in the mountain,—an occurrence very common in mountains of hornblende-slate, of which I am inclined to believe the hills of both countries are chiefly composed.

The climate of New Shetland would seem to be very temperate, considering its latitude; and should the expedition now sent out bring assurances that the land is capable of supporting population,—an assumption which the appearance of trees renders very probable, the place may become a colony of considerable importance. So little advanced as the season must be in October, the atmosphere was by no means cold: it was pleasantly temperate, like that felt in the north of Scotland at a similar season. Even in June, the very depth of winter, nothing like excessive cold was experienced.

The prompt measures adopted by the Naval Commander on the station merit the warmest praise, for having availed himself of every means he could attain for arranging the survey. Those who are aware of the extent to which the whale-fishery may be carried on in this hemisphere, must be immediately struck with the immense benefit which the acquisition of New Shetland might offer as a British settlement. We have only to call to view the chance we stand of being outrivalled by another maritime nation, there being at this time upwards of 200 American whale-ships lucratively employed in the Pacific, when Great Britain cannot boast of more than 30 or 40. We have only to state this fact, to exhibit the advantage of this settlement as connected with that branch of trade; but if we take into view the whole mercantile trade with Buenos Ayres, Chili, Peru, and the immensely extensive provinces of the interior, which is increasing with strides unknown, and establishing a demand for articles of British manufacture that must eventually prove the channel for the consumption of British produce, and the employment of British capital; if we consider, too, that these places must eventually become established as places of barter and entrepôt to our India and China trades, —then must the importance of the situation, if it can admit of a settlement, be strikingly apparent. Comparing this spot with the Cape of Good Hope and New Holland, it will be seen that these three places form equidistant depôts in the Southern Hemisphere, respectively situated so as to defend, if not to command, a superiority of trade with more extensive markets than were ever offered to any commercial nation at any former period of the world; and this, too, at a time when the late eventful circumstances in the history of Europe have turned in no small degree British commerce out of those channels in which it has flowed uninterruptedly for so many years.

No one can deny that the want of a British settlement contiguous to the coast of South America is seriously felt; for since the abandonment of the Falkland Isles, we have no possession, —not even a watering-place,—nearer than the Cape of Good Hope or New Holland; and no one can calculate upon the absolute necessity Great Britain may one day feel for such a possession. Under every point of view, as well national, commercial, and scientific, must the discovery of New South Shetland be valued; and without doubt the results of the present expedition will be anxiously looked for by every wellwisher to his country *.

VALPARAISO, *January* 1820.

ART. XXII.—*Extract from the Journal of* Captain HENRY KING *of the Elizabeth.*

ON the 20th of February 1819, having completed a cargo of sperm oil, we made all sail to the S. S. W., intending to touch at Pitcairn's Island, for the purpose of refreshing the crew previous to our doubling Cape Horn. Knowing we were pursuing a track not much frequented, I directed a particular look out to be kept, as I had before found our charts of these seas very defective, and as it is well known to many who frequent them that there are several dangers in existence, the positions of which are set down very erroneously.

The weather was generally cloudy, with passing squalls of wind and rain, till the 25th, on which day we observed a great many pigeons, and other kinds of birds, which indicated our proximity to the land. Accordingly, we kept a good look out, but saw nothing like it; the next day we saw no birds. Our latitude, when the greatest number of birds was seen, was 17° South.

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* We understand that Captain Basil Hall, F. R. S., has been sent out for the purpose of exploring and surveying this new region. The highest expectations may be entertained from the known skill and enterprise of our eminent countryman.—ED.

On the evening of the 28th of February, we again saw numbers of pigeons similar to those observed by navigators in the neighbourhood of St Helena. Being convinced that some island must be near, and a long squally night before us, I thought it most prudent to keep under easy sail for the night, and gave particular orders for a good look out. At 5 A. M., on the morning of the 1st of March 1819, I was informed by the second officer (whose watch it was,) that there was a large island on the weather-beam, and that it was as level as a bowling-green. I immediately went on deck, and hauled by the wind, intending, as it was near day-light, to prepare two boats, with men and arms, to go on shore and visit this new discovery. Accordingly, at day-break, we tacked in for the island; and at 10 A. M., taking with me the surgeon and second officer, I went in two boats, to endeavour to land at a sandy-beach not far distant from the ship, which, after some difficulty, we accomplished. After hauling the boats up among the trees, we all went up in different directions; within hail of each other, in quest of vegetables or animals; but, after a search of four and a half hours, we returned to the boats, having seen one parrot, and shot a few pigeons. The island abounded with young trees and underwood, nor did we observe the smallest appearance of quadrupeds, except here and there a rat; the ship's name, Elizabeth, was now given to the island. The British Colours were displayed on the island, and greeted with three cheers, and a bumper of grog was drank to the health of his Majesty. The ship returned the compliment, by hoisting her colours and performing the same ceremony. While these ceremonies were performing, a proper person was employed in carving the ship's name, and the other particulars upon a tree, near the spot where we landed. I at first intended to have inclosed a letter in a bottle, and buried it near some remarkable place, in order that our prior discovery might be more easily proved, should it ever be disputed; but the surf increasing considerably, and the ship being at too great a distance to have communication with her before dark, I gave up this idea. We landed on the south-west part of the island, among some coral rocks, at the back of which is the beach before mentioned. It appears about six leagues in circumference, and we found no anchorage; but I think opposite to the sandy-beaches to the northward of our landing-place, anchorage would be found. The latitude of Elizabeth's Island is 24° 26′ S., longitude west of Greenwich 127° 50′. At 3 P. M., joined the ship, and made sail at 10 P. M.

On the 2d of March we saw Pitcairn's Island: At 5 P. M. of the same day we were within half a league of it, and could not persuade ourselves, from the barren appearance of the hill, that any person who had ever seen the fertile hills and dales of Great Britain, would ever fix their residence among these barren mountains. We stood off and on all night, under easy sail, and shewed a light in the main-rigging, which was answered by two large fires on shore. A young girl, named Dorothy Young, (as we afterwards were told,) had been at work at a plantation opposite to the ship, ran to the village, and told them of our arrival, in consequence of which they made the fires in answer to our light. About 6 A. M., on Wednesday, March 3. I stood the ship close in to what the inhabitants call Ship-landing-place, (from the circumstance of the Bounty being hauled on shore and burnt at this place,) in expectation that some of the inhabitants would probably come off to me. I hove to with our head off, and prepared a boat to go on shore; in a few minutes after, we saw a boat with nine men come out from amongst the rocks, through a tremendous surf. I now sent my boat to meet them, and tow them on board. When they came alongside, they ascended the ship's side with much good humour, and came aft on the quarter-deck where I was, and taking me by the hand, gave it a hearty shake, and said, "How do you do Captain." They then asked the ship's name, my name, where bound, whence from, and made many other trifling inquiries, in very good English. After satisfying them respecting these matters, I invited them into the cabin, and set before them some salt-beef, grog, biscuit and porter, with which they seemed pleased. Putting their hands before them, in the position of prayer, and saying grace, they began to refresh themselves, and were much pleased with the porter. While they were eating, I had leisure to survey their fine open countenances, which (notwithstanding their exposure to the sun) were truly British. They were nine young men, the offspring of the deluded crew of the Bounty, most of them standing six feet high, very muscular and agile, of an engaging deportment and open disposition. After their repast, they returned thanks to God, in the same pious manner as before. They then went on deck, where they gave surprising proofs of their agility, by going aloft, jumping overboard, and swimming round the ship, while it was going through the water at the rate of two knots per hour. I now prepared to go on shore, and took the surgeon with me. Five of the natives accompanied us to assist in landing, the others remained on board till my return. When I got near the shore, I found the surf so violent, that I durst not attempt with my boat to go through it. I went into theirs, when one of them taking hold of me, bid me not fear, for should the boat upset, he would take me safe on shore. We now entered the surf, when, to my great surprise, a number of young women and children came half way into the surf to assist in landing the boat. These women ventured far beyond their depth, and assisted in bearing the boat up, by swimming and sustaining it with their hands. We landed in safety, and were immediately met by John Adams, a hearty corpulent old man, who, like the rest, was naked, with the exception of a piece of cloth round his middle. He invited us to his house, for which we set out directly, accompanied by all the population of the island. Our way lay up a very steep hill, and along a foot-path so narrow, that they were actually obliged to carry the Doctor up. When we attained the summit of the hill, we had a fine road through the woods; and after crossing two valleys, which abounded with cocoa-nut trees, we arrived at the village, situated in a beautiful valley, in which were seven houses, each of which had a fine lawn before it. Two of the houses had a storey above the ground, and all had very clean convenient places for their poultry and pigs. We stopped at the house of Thursday October Christian, the first born on the island, who gave us for dinner a sucking pig, cooked after the Otaheitean manner, two brace of fowls, and plenty of yams and plantains. After dinner, were served up bananas and a species of apple peculiar to the island, which we found very good. Every thing was clean, and conducted with great propriety. Grace was said both before and after dinner; John Adams saying it first, then every one in rotation, according to their seniority. After dinner, we took a look at the different plantations, and found that most of their labour consisted in raising yams. There was an abundance of plantains and some sugar-cane, from which they extract molasses and liquor. The land appeared capable of producing any thing, and abounded with many esculent roots that we had never before seen, nor could the surgeon, who upon this occasion was our botanist, find names for them. During our excursion, we were shewn a very curious tree. The trunk was about six feet in circumference, and proportionally long: the trunk, with the root and all its ramifications and earth about it, was lying in a horizontal position above the surrounding trees. The largest trees upon the island were in this manner. It appeared as if the branches had taken root downwards, and drawn the parent tree up; but we could not account for its unseemly position. John Adams informed us there were plenty upon the island growing in the same manner.

In the evening, after supper, they entertained us with an Otaheitean dance, which consisted of various writhings and distortions of the body, by no means obscene, yet in no respect pleasant. While some were dancing, the rest sat down to look on, in company with six sailors belonging to the ship, when suddenly one of the young women jumped up and ran to her brother, saying, "she would not sit any longer near that naughty man (pointing to one of my sailors), for he wanted her to commit fornication." I asked the man why he behaved so rude to people that had treated him so well? He told me that it was by mere accident he put his foot against hers, and that he had never spoken to her. After the Otaheitean dance, the sailors shewed their abilities in dancing, which excited great laughter and diversion. After the dance, we were shewn to bed; the surgeon and myself slept in the same room. We had each of us a good feather-bed and clean sheets, made from the bark of a tree, where we slept very comfortably all night. In the morning, we breakfasted on fowls and a beverage like tea, made from a root similar to the gentian, but which they called ginger. After breakfast we returned to the Ship Landing-place, to endeavour to go on board; but the sea was too high. Davy, as they called the sea, had never been so bad before, excepting once in their remembrance. We were all sitting down in conversation, when a little child ran down to go into the surf. I ran to prevent the child, and so did the wife of Charles Christian, saying at the same time to Diana, the eldest daughter of John Adams, " Diana, your child will be drowned." Adams having told me, prior to this, that his daughters were not married, I expressed my surprise to the wife of Christian. Old Adams hearing this, took me aside, and gave me the following account: Notwithstanding his paternal care of his daughters, Edward Quintral and Diana had committed an offence against the laws of God, for which he supposed them worthy of death, and accordingly gave orders that they should be shot; but as no person seeming willing to execute his orders, he made the necessary preparations for executing them himself, when he was strongly opposed by Auther Quintral, who said that though the offence was certainly a great one, and the more so, as a similar one had not been committed since the death of Christian; yet he did not conceive it to be a crime worthy of death. The rest being of the same opinion, Adams changed his mind also, but forbade them to marry. Adams, upon this occasion, probably changed his mind through interest, for he will not suffer his daughters to marry for fear of losing their labour in cultivating his plantation.

As we could not go on board, I now searched for a watering-place, and found a very convenient one in moderate weather, and with excellent water. Each family gathered together some poultry, hogs, goats, plantains, and every thing the island produced, and next morning, Davy being milder, we went on board, accompanied by the whole population of the island. As most of them had never seen a ship, they were much pleased, but soon grew sea-sick. I now gave them a whale-boat, in return for their refreshments, some books, razors, combs, and, in short, every thing they stood in need of; but nothing pleased them so well as the books: as they wished much to read and write. I offered Auther Quintral two claw-hammers, which he refused; and Adams, who was present, told him, that it was very improper to refuse any thing their countrymen offered: Auther replied, it was much more improper to take things that they do not want. While Adams was on board the ship, he gave me a brief account of the different occurrences that had taken place upon the island; and, among others, he mentioned his divorcing Christian and his wife, in consequence of having read in the Old Testament that marriages should not be allowed among those who were at all related to each other, and that they had lived separate a long time. After a great deal of conversation upon the subject, I persuaded him to allow Diana, his daughter, to be married to Edward Quintral, and Christian to live with his wife, both of which he promised to do; and calling Edward to him, he took him by the hand, saying, "Come here, my son, you shall have my daughter Diana, and to-morrow we shall keep the wedding." I now gave him some porter, wine, and spirits, to regale themselves with at the wedding. Every person in the ship was so struck with their simplicity of manners, the mildness of their language, and their modest deportment, that they were loaded with presents: They got nearly two hundred books, of various descriptions, from the officers and crew;—even the sailors belonging to the ship behaved with a degree of modesty in the presence of these naked females, that would have surprised a Joseph Andrews. John Adams now assembled his family in order to take leave, which they did in the most affectionate manner; and so grateful were they for the few things they had received from the ship, that they all kneeled down to kiss my hand, which I could by no means permit. I promised, should I come again to the island, that I would bring them some black cattle, and particularly some asses, of which they said they were greatly in want. They now went into their boat with some reluctance, particularly one young man who wished to see his friends in England, but his mother, with tears in her eyes, requested that I would not take away her son; nor were we ourselves free from regret, at leaving a people whom we considered in a moral point of view as far superior to any of the human species we ever beheld. Two young men belonging to the ship asked me to let them remain upon the island,—a request I could by no means comply with. After seeing them safe among the rocks, we made all sail, the wind being fresh from the eastward. As we were bound round Cape Horn, we sent down our royal masts and yards, and made every thing as snug as possible; for after the experience of seven voyages round Cape Horn, I am authorised to say, that preparation ought to be made for stormy weather at all seasons of the year; and I am also of opinion, that ships bound round Cape Horn from the eastward, should endeavour to be off the Cape in the winter, as I have invariably found easterly winds at that time. We experienced a very fine passage to St Helena, where we refreshed the crew, refitted the ship, and arrived safe at Deptford on the 13th July 1819.

P. S. Adams told me, that the island had been inhabited prior to their settling upon it; for they had at several places dug up great quantities of human bones, which induced them to believe, that those places had been appropriated for the interment of the dead. They had also found below the surface of the earth a great many images. I did not hear whether they had found any metals; but I recollected, after leaving the island, that the stones with which they sharpened their tools, appeared to have a yellowish metallic appearance; and also some veins of yellow metal in them. I much regret not having examined them more closely, or bringing a piece with me.—One of the sailors gave a shilling, to be tied round the neck of one of their children; but before I left the island it was brought to me, to be restored to the donor, observing at the same time, that they had no use for it, and it would buy him something when he got to England. Old Adams informed me, when they first settled on the island, that there were plenty of fish; but for some time before my touching at this place, they could not catch any, and they thought the copper of the Bounty had poisoned them all. I have before observed, that the island produces yams, and other esculent roots, which we could not find names for. I presented them on my departure with some pease, barley, flour, orange, melon, pumpkin, celery, and many other seeds, which I had saved during my voyage, (intending to give them should I ever touch at the island). Salt is procured among the rocks, the sea being hove into the cavities during the blowing weather, is left there, and by the rays of the sun produces salt, a circumstance very common in warm climates. The only birds, which I saw were pigeons and sea-gulls.—George Young carried the Bounty's anvil and swivel from the Ship Landing-place, up the steep foot-path, (where the Doctor was carried up); the anvil was as much as I could well lift, and he says he could have carried the anchor also.

Names of Persons found on Pitcairn's Island.

JOHN and MARY * ADAMS.
Rachael Adams, spinster.
Hannah Adams, do.
George Adams, 15 years.

THURSDAY OCTOBER CHRISTIAN and Wife *.
Joseph Christian, 14 years.
Charles Christian, 12 do.
Mary Christian, 8 do.
Poly Christian, 6 do.
Margaret Christian, 4 do.

CHARLES and SARAH * CHRISTIAN.
Sarah Christian, 9 years.
Fletcher Christian, 6 do.
Edward Christian, 4 do.
Maria Christian, 2 do.
Charles Christian, 6 months.

MARY ANN CHRISTIAN, spinster.

DONALD and SARAH MACCOY.
William Maccoy, 7 years.
Donald Maccoy, 5 do.
Hewey Maccoy, 2½ do.

ELIZABETH MILLS, widow.
John Mills, 7 years.
Mathew Mills, 5 do.

AUTHER and CATHERINE QUINTRAL.
Auther Quintral, 2½ years.
Catherine Quintral, 6 months.

EDWARD and DINAH QUINTRAL.
John Quintral, 1½ years.
JANE QUINTRAL, spinster.

MARY YOUNG, spinster.
Dorothy Young, do.
Edward Young, bachelor.
Robert Young, do.
George Young, do.
William Young, do.

MRS CHRISTIAN *sen.*
Tohai,
Tohai,
Otaheitean women.

◆

DEATHS ON THE ISLAND.

John Adams' 1st wife * fell off the mountain.
† An Otaheitean woman, grief.
† An Otaheitean do. dropsy.

Fletcher Christian,
Isaac Martin,
William Brown,
John Mills *sen.*
John Williams,
Murdered by Otaheitean men.

‡ Taimor,
‡ Heiaho,
‡ Taralow,
Killed each other.

‡ Manody,
‡ Nehow,
Killed in a scuffle with the English.

‡ Tetohita, Killed with an axe by his countrywoman.

James Young, 7 years,
John Quintral, 5 years,
Dropsy.
Mathew Quintral *jun.* drowned in a fit while fishing.
William Maccoy, drowned, insane.
John Mills *jun.* fell off the mountain.
* Sarah Quintral, do. do.
Mathew Quintral, killed in a scuffle among themselves.
Edward Young *sen.* asthma.

* Otaheitean women.
† Came to the island with the mother.
‡ Otaheiteans.
All the rest English, and those born on the island.

Art. XXIII.—*Description of a Volcanic Eruption in the Island of Sumbawa.* By Mr G. A. Stewart *.

In April 1815, there occurred on the island of Sumbawa a volcanic eruption, as tremendous, perhaps, in its nature, and as destructive in its effects, as any on record.

The mountain from which this took place is called Tanbora. Its summit is calculated to be in lat. 80° 20′ S. and in long. 118° E. Its base is of great extent; but its summit did not to me appear higher than from 5000 to 7000 feet above the sea, which washes the base of the hill for three-fourths of its extent.

From the 5th to the 11th of April 1815, the mountain emitted dust and frequent loud sounds every day. The dust caused a haziness of the atmosphere at places many degrees distant from Tanbora; and the noises which were heard equally far off, sounded at Beema, (a town about sixty miles east of the hill), generally like the firing of the largest cannon close to the ear; at other times the noises were of a rumbling kind.

On the night of the 10th, and morning of the 11th of April, the loudness and frequency of the reports increased. The showers of greyish black dust which had been falling at Beema increased so much by 7 A. M. on the 11th, as to produce there a total darkness. This complete darkness continued until 7 A. M. on the 12th, after which the dust fell in less and less quantity, and at noon it entirely ceased.

Pumice-stone of a brown colour was thrown out in immense quantity at the crater of the mountain. Great fields of it, with scorched trunks and branches of trees, were afterwards found floating in the neighbouring sea; and much of these were thrown up on the shores of Bally Java, Madura, Celebes, &c. These shoals were troublesome, and even somewhat dangerous, to ships passing near them. The country ship Dispatch fell in with many fields of this pumice-stone and wood, and was obliged to steer clear of them; some of the pieces of wood were noted in its log-book as being about "six feet in diameter, and of a very great length."

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* Abridged from the Transactions of the Literary Society of Bombay, vol. ii.

Trees of great size (many from sixty to eighty feet long) were thrown into the sea; they seemed to have been scorched, and to have had their small branches and roots torn off. Some of those trees I saw sticking in the mud near the shores of the bay of Beema, with one end uppermost.

Some of the houses of the town of Beema were materially injured by the discharges from the mountain.

It was reported by Captain Eatwell, of the Honourable Company's cruizer Benares, that the earthquake attending the eruption had raised a bank on which that ship struck, in a place where the Honourable Company's cruizer Ternate, some months before it, had floated in safety.

The people living on the peninsula formed by the mountain had traded much in horses, of which their country produced a very good small breed. Thousands of them and their horses were, according to all accounts, destroyed by the eruption: the vegetation was ruined, and multitudes of the people obliged to emigrate in order to obtain subsistence.

I understand that at the town of Tanbora, situated at the bottom of the west side of the mountain, the sea has made a permanent encroachment, burying that town to the depth of three fathoms.

Three distinct streams of a dark-coloured lava, according to the report of the people on the island, issued from the hill; of these I could observe something as I passed going to Beema in July following. One stream on the east side of Tanbora seemed to be emitting smoke and vapour even at that time.

During the darkness, the sounds before described were particularly loud and frequent. At times, indeed, they were so loud as to produce momentary earthquakes of no inconsiderable violence.

All this, while there was no wind in any direction in the neighbourhood of the mountain, or at some distance from it; yet the sea was so violently agitated as to wash away some houses near it on Sumbawa, and to throw on the beach near the town of Beema sev[illegible]e trading boats that had been at anchor in the bay.

One of the most [illegible]mstances of the eruption is the experience of it[illegible]nse distances. At Samanap, on the island of Madura, in Lat. 70° 5′ S. and in Long. 113° 57′ E., there was, according to the information I received from Mr Liddel, master attendant there, and who was at Samanap at the time, total darkness, in consequence of the falling dust, from 5 P. M. of the 11th of April until 11 A. M. of the 12th. The explosions were very loud at that place, and were heard for several days.

At Somabaya, the darkness was complete from about 6 P. M. on the 11th until 4 P. M. on the 12th. The sounds were described to me as being exceedingly loud. They had been heard at Somabaya, and dust had been observed to fall for several days before the 11th, during which time the wind was eastwardly and light: on the afternoon of the 11th, a very thick haze resembling a cloud, was observed coming from the eastward. It proved to be the cloud of dust from Mount Tanbora. The anchorage in Somabaya roads is in lat. 70° 14′ S. and in long. 112° 58′ E., *i. e.* about five degrees distant from Tanbora.

Similar but slighter effects of the eruption were felt at Batavia, in Lat. 60° 10′ S. and in Long. 106° 51′ E.; at Java Head, still further off, being in Lat. 60° 48′ S. and Long. 105° 11′ E.; at Minto, on the island of Barca; and at Bencoolen, or Sumatra, in Lat. 3° 48′ S. and in Long. 102° 28′ E.

At Macassar, in Lat. 5° 10′ S. and in Long. 119° 38′ E. the effects of the eruption were felt nearly at the same time as at Somabaya, but in a more violent degree.

The explosions from the volcano were so violent there, as to astonish every one; they shook the earth, and broke panes of glass in the windows of several houses. The cloud of dust was seen coming from the south. There was no wind.

With a view to ascertain the quantity of dust falling in a certain time, Mr Paterson, surgeon of the residency there, put a table into the open air for an hour, between 6 and 7 P. M., at which time the dust was falling in great quantity, and the darkness total. The dimensions of the surface of the table were five feet two inches by four feet eight inches; the quantity of dust which fell upon it by 7 P. M. was 15,064 grains at Beema; the quantity of dust found lying on the ground after the eruption was guessed to be at a medium of three inches and a half in depth: at Somabaya the depth of it was something less.

At the island of Ternate, in Lat. 0° 19′ N. and in Long. 127° 29′ E., the explosions were distinctly heard about noon on the 11th of April; dust was not perceived to fall there, nor did any person notice that that day, or any one of those immediately following, was at all darker than ordinary.

In the island of Amboyna, on the 11th or 12th day of April in the same year, a violent earthquake was felt. In the ground of a gentleman near the Government-house, the earth was observed to open, to throw out a gush of water, and immediately after to close. The sea in the neighbourhood of Amboyna was violently agitated during that month, rising to high-water mark and sinking to low-water mark in the course of ten minutes. For several days, at the same time, the sun appeared (according to a letter from the late Lieutenant White, of the Bombay marine, then at Amboyna) of a green colour, encircled with a haze. Fort Victoria, on Amboyna, lies in Lat. 3° 40′ S. and in Long. 128° 14′ E.

The inhabitants of the island of Banda, one of the Moluccas, experienced shocks of an earthquake at the time of the eruption of Mount Tanbora.

ART. XXIV.—*Some Observations on the Solar Eclipse, September* 7. 1820. By THOMAS JOHNSON, Esq.

FOR several days prior to the 7th, I examined the sun with a reflector, in order to see whether or not any spots were on the disc; but none could be seen. The morning of the 7th was clear and fine; there had been a dense fog in the night. At 6 A. M. the thermometer in the shade stood at 52°, a little wind S. E. by S. At nine the thermometer reached 66° 30′, wind S. S. E. At 10 thermometer 64°, fresh wind S. by W., thick fleecy clouds, at a low elevation, gliding rapidly before the wind. 11 A.M. thermometer 65°; 11^h 49′, thermometer 69°. At noon very cloudy, therm. 70°, increased at 0^h 7′ P. M. to $70\frac{3}{4}$; 0^h 23′ 69°. At 0^h 51′ first observed the sun, but by no means clearly, a considerable portion was then eclipsed: large masses of dark clouds rising from the S. very soon obscured the sun again. The next time there was an opening, (I did not note the time, but believe it was about 1^h) and the sun was for about five minutes tolerably clear, I observed with my reflector a slightly palish light on each side of the moon, near *a*, *b*, where the extreme points, or apparent horns of the crescent of the sun, were in immediate juxta-position with the moon; the streak of light on the eastern side being rather lighter and more extended than that on the western. When I first saw this appearance, I supposed it to be some optical illusion, or the consequence of some defect in the specula of the telescope; and, in order to try if either of my conjectures was right, I immediately took another glass, (an Achromatic of Dollond, with a spray shade,) but before I could get it adjusted, the sun was again obscured *.

Towards 1h 30′ the heavens became clearer and brighter, and the eclipse was again visible for a short time, therm. 64°. No appearance with either glass of the bright appearance on the moon. At 1h 42′ P. M. I observed Venus, with the naked eye, and very clearly with the Achromatic. About this time (the therm. 61° 25′) unsized paper, thickly smeared with pulverised gunpowder, and made very dry, could not be fired by the sun's rays, collected to a focus by a powerful double convex lens. A gentleman in company thought he perceived it smell as if burning, but I could neither smell nor see any appearance of its doing so. Very soon after this, a black cloud again put a stop to our experiments and observations.

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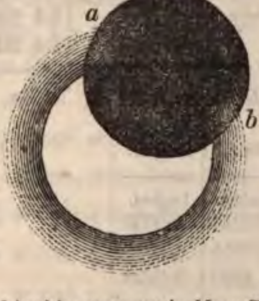
* I annex a rude and hastily sketched drawing of the appearance, as correct as I am able to recollect it. An intelligent friend, whom I have seen since the eclipse took place, mentioned to me his having observed the same appearance (for about one minute) with a common telescope, with a smoked eye-glass. The appearance of the light streaks vanished as my friend was observing them. I think I observed them from 2¼ to 3 minutes.



The different hours noted in this paper are in Mean Time. The thermometer hung at about 20 inches distant from a north wall.

Thermometer as before. I was informed that several domestic fowls in my yard went to the place wherein they roost, as if for that purpose, but did not actually perch. At 2^{h} 14′ we had another gleam; touch paper was readily burnt, by help of the lens. At 2^{h} 37′ it instantly inflamed with intensity. About 2^{h} 43′ the sun became so much obscured by clouds, that little could be seen, and so it continued till the eclipse was over, except for about 1½ min. just before 3. The thermometer gradually rose to about 64° 30′, or a little more, but reached no higher during the remainder of the day. The gloom at the greatest occultation was to the full as considerable as I had expected. I thought it was equal to the twilight, when the sun is from 6° to 7° below the horison. Venus, I think, becomes visible when the sun's depression is 4½° or 5°.

Hill-Top, Wetherby,
9th Sept. 1820.

Art. XXV.—*Quarterly Abstract of the Diurnal Variation of the Magnetic Needle, &c.* By Colonel Beaufoy, F. R. S.

Monthly Mean Variation of the Magnetic Needle.

Variation West.

May,	Morning,	24° 30′ 42″
	Noon,	24 40 08
	Evening,	24 33 00
June,	Morning,	24 29 50
	Noon,	24 39 16
	Evening,	24 33 48
July,	Morning,	24 28 41
	Noon,	24 39 00
	Evening,	24 33 26

Rain and Evaporation.

Month.	Rain.	Evapor.
	Inches.	Inches.
May,	3.383	4.270
June,	1.724	4.391
July,	1.936	3.950

Mean Heat.

May,	53°.40
June,	58.47
July,	60.75

Latitude, 51° 37′ 44″.3 N.; Longitude west in time, 1″ 29.

Aug. 10.	Immersion of Jupiter's 2d Sat.	11h 13′ 30″ mean time at Bushey. 11 14 51 mean time at Greenwich.
Aug. 13.	Immersion of Jupiter's 1st Sat.	13 52 27 mean time at Bushey. 13 53 48 mean time at Greenwich.

BUSHEY HEATH,
STANMORE, *Aug.* 17. 1820.

ART. XXVI.—*Proceedings of the Royal Society of Edinburgh.* (Continued from Vol. III. p. 183.)

June 1. 1820. AN abstract of a mathematical paper by Professor WALLACE was read.

In the year 1808, Mr Wallace communicated to the Royal Society a paper on the Quadrature of the Conic Sections, and the Computation of Logarithms, which was published in the 6th vol. of its Transactions. In that paper, general expressions were given for the reciprocal of any elliptic or hyperbolic sector; also for the reciprocals of its second and third power, and analogous expressions were investigated for the reciprocals of the powers of the logarithm of a number. These were found by principles at once simple and elementary, without any reference to the fluxional or other equivalent calculus; and, unlike the ordinary series, which in some cases converge too slow to be of any practical use, they are always applicable. In the paper to which this notice refers, the same elementary principles are applied to the investigation of new series, for the simple powers of the areas of elliptic and hyperbolic sectors, and for the logarithm of a number, and these are at once simple and symmetrical in their form, and universally applicable. From the general expression for the area of the sector of any conic section, we derive the following for the arc of a circle.

Let a denote any arc of which the rad. $= 1$.

Put v for $1 - \cos. a$

n for $1 + \cos. a + 2 \cos. \frac{1}{2} a$

n' for $1 + \cos. \frac{1}{2} a + 2 \cos. \frac{1}{4} a$

n'' for $1 + \cos. \frac{1}{4} a + 2 \cos. \frac{1}{8} a$

n''' for $1 + \cos. \frac{1}{8} a + 2 \cos. \frac{1}{16} a$

and so on.

Then $a = \sin. a\,(1 + \frac{v}{n} + \frac{v}{n\,n'} + \frac{v}{n\,n'\,n''} + \frac{v}{n\,n'\,n''\,n'''} + \&c.)$

The expressions for elliptic or hyperbolic areas, and for the logarithm of any number, are exactly of the same form.

The terms of this expression are formed from the cosines of a series of arcs or sectors, which constitute a geometrical progression. In like manner, the terms of the expression for an elliptic or hyperbolic sector, are formed from a series of abscissæ corresponding to elliptic and hyperbolic sectors, each of which is one-half of that before it. These abscissæ are found by precisely the same formula in the two curves; and in the beginning of the paper, general theorems are investigated, which express the relation between the co-ordinates corresponding to an elliptic or hyperbolic sector, and those which correspond to any multiple of that sector. The theorems are deduced from a single property common to both curves, without employing any geometrical constructions, and without introducing impossible quantities.

Mr Thomas Allan read an account of a Petrifaction found in the neighbourhood of Edinburgh.

At the same meeting, a paper by Mr Hercy was read, On the effects of injecting a solution of Opium into a Vein, in an anomalous nervous affection.

At the same meeting the following members were elected:

HONORARY MEMBER.

Count Berthollet.

FOREIGN MEMBERS.

M. Vauquelin.
M. Legendre.
M. Brochant.
Baron Von Buch.
M. Berzelius.
Baron Krusenstern.
M. Sismondi.
M. Poisson.
M. Prony.
M. Gauss.
M. Blumenbach.
Count Volta.
M. Kaussler.
M. Degerando.

ORDINARY MEMBERS.

John Hay, Esq. younger of Hayston.
Captain Robert Hay, R. N.
Dr Ballingall.

The Society adjourned till November next.

Art. XXVII.—*Proceedings of the Wernerian Natural History Society.* (Continued from p. 184.)

August 5. 1820.—Mr Sivright communicated to the Society a short account of a series of experiments he had made on the teak wood, (in confirmation of those previously made by Dr Wollaston,) from which it appears, that it contains a considerable quantity of silica, specimens of which he laid on the table. He intimated his intention of examining other hard and heavy woods, with the view of discovering their constituent parts and other properties.—See p. 413.

The Society adjourned till November.

Art. XXVIII.—*Proceedings of the Cambridge Philosophical Society.*

As the following abstract of two interesting papers, read by Mr Herschel, before the Cambridge Philosophical Society, did not reach us till after that part of our number was printed, we avail ourselves of the present opportunity of laying it before our readers.

April 17.—A paper by J. F. W. Herschel, Esq. was read, *On the rotation impressed on the planes of Polarization of the rays of Light by plates of rock-crystal, as connected with certain peculiarities in its crystalline form, &c. &c.*

In this paper the author has entered into an examination of that peculiar variety of crystallization in quartz, to which Haüy has given the name *Plagiedral.* The peculiar faces which characterise this variety, are situated unsymmetrically with respect to the axis of the primitive rhomboid, and in the same crystal uniformly appear to lean as it were in one and the same direction around the adjacent summit, while in different crystals these directions differ. Mr Herschel has found, that the direction of these faces, in all such crystals as he has been able to procure, is the same with that in which a plate cut from them at right angles to the axis, turns about the plane of polarization of a ray transmitted along the axis. From this invariable correspondence, he concludes, that the forces which produce the rotatory phenomena are the same with, or in some way dependent on, those which have operated in producing these singular decrements.

May 1.—A paper by J. F. W. Herschel, Esq. was read, *On the action of Crystals with one axis on homogeneous light.* The object of this paper is to shew, that among crystals with one axis of double refraction, the utmost diversity prevails in the scale of tints they develope on exposure to a polarised ray, and that their action in polarizing the differently coloured rays, is by no means proportional in all of them, or regulated by any simple or general law. The minerals confounded together under the common name of Apophyllite, are a strong example of this. In one variety of this body, the rays of all colours are polarized with nearly equal energy, the slight *maximum* of action falling between the yellow and green. In a second, the polarizing energy descends rapidly from the red to the yellow, where it is almost insensible, and then rises still more rapidly to the violet, where it exceeds the action on the red. A third has a *minimum* and almost insensible action on the indigo, from which it increases rapidly on both sides of this colour, and is greater on the red than on the violet rays. These three varieties all exhibit circular rings, whose tints deviate enormously from Newton's scale, (in which the action increases regularly from the red to the violet,) and were all found united and cohering in a single crystal: another instance of deviation from Newton's scale is produced in the hyposulphate of lime, (a crystal with one axis). From all these Mr Herschel concludes, that the law of proportional action on the differently coloured rays in all crystals is utterly unfounded, a conclusion to which he had been before led by observations on Rochelle salt.

ART. XXIX.—SCIENTIFIC INTELLIGENCE.

I. NATURAL PHILOSOPHY.

[redacted]NOMY.

1. *Observatory* [redacted] The new observatory at Göttingen, which was [redacted] completed under the direc-

tion of the celebrated M. Gauss, is now provided with fixed instruments of high perfection, viz. a meridian-circle by Repsold; and another meridian-circle and transit-instrument by Reichenbach. These instruments, which are circumstantially described in the literary Gazette of Göttingen, (*Göttingishe Gelehrte Anzeigen*, 1818, p. 1257; 1819, p. 1665; 1820, p. 905.), are so perfect, that the two last shew, under favourable circumstances, at noon, stars of the fourth or even of the fifth magnitude. A regular course of observations is carried on at the observatory. M. Gauss, in concert with the astronomers of four or five other observatories, has been carrying on for some time a series of observations upon a fixed plan. The object of that plan is to determine the difference between the meridians of the observatories, by observing the right ascensions of the moon when she passes over the meridian. The moon is usually compared each night from the first quarter till after the full with threes tars (previously selected and before announced to the five astronomers) near the moon, and almost on the same parallel. The harmony of the results has been greater than was expected, and is in some cases very surprising, as in the following examples:

Meridian Difference between Göttingen and Konigsberg.

		Difference of Meridian.
1820, Feb.	22. two stars, - - -	42′ 10″.8
April	21. one star, - - - -	42 12 .8
	22. three stars, - - -	42 13 .6
	23. two stars, - - -	42 14 .8
	26. two stars, - - - -	42 10 .0

Meridian Difference between Göttingen and Dorpat.

1820, April	22. three stars, - - -	67′ 6″.7
	23. two stars, - - - -	67 8 .6
	25. two stars, - - - -	67 5 .3

2. *Comet of* 1819.—This comet is expected to arrive at its next perihelion about the middle of May 1822, but it will be scarcely visible at that time in any part of Europe. Before it reaches its perihelion, it will be too distant from the Earth, and afterwards it will be too far to the south to be seen in Europe. In the southern hemisphere, however, it will be finely seen, and

at the end of June in S. latitude 77°, its light will be more than 26 times as intense as when it was discovered at Marseilles on the 26th November 1818. The following elements have been deduced by Dr Brinkley from three observations made on the meridian, on the 4th, 5th and 6th of July, and further corrected by observations on the 4th, 13th and 20th of July.

Passage of perihelion at Observatory of Trinity College, Dublin. Mean time.	June 27, $16^h\ 26'\ 46''$
Perihelion distance, - - - -	0.341051
Longitude of node, - - - -	$9^s\ 3^{\circ}\ 43'\ 44''$
Inclination, - - - - - -	$80^{\circ}\ 45'\ 53''$
Place of perihelion, - - - -	$9^s\ 17^{\circ}\ 5'\ 5''$
Motion direct.	

3. *Figure of the Sun.*—M. Mosotti, in a Memoir on the Figure of the Sun, after giving analytical expressions for the horizontal and vertical diameters of that planet, compares the values which they furnish with 1683 observations of the sun's diameter made by M. Cesaris, and he arrives at the same conclusion which M. Littrow had deduced from more than 400 of Maskelyne's observations, viz. that the sun is elongated towards its poles $\frac{1}{333}$. The determinations of M. Piazzi, and the application of M. Mosotti's formulæ to some observations of M. Carlini, give the opposite result, that the sun is flattened about $\frac{1}{330}$ at its poles.—*Ephemerides de Milan*, 1820.

OPTICS.

4. *Case of Lateral Mirage.*—A curious case of lateral mirage was observed at Geneva on the 17th September 1818, at 10 o'clock, P. M. by MM. Jurine and Soret. A bark near Bellerive, at the distance of about 4000 toises from Geneva, was seen approaching to Geneva by the *left* bank of the lake; and at the same time, an image of the sails was observed above the water, which, instead of following the direction of the bark, separated from it, and appeared to approach Geneva by the *right* bank of the lake,—the image moving from east to west, while the bark moved from nort [illegible] When the image separated from the bark, it was o [illegible] ensions as the bark; but it diminished as it re [illegible] o as to be reduced to one half when the mirage [illegible] *de Physique*, Mars 1820, *tom.* xc. p. 217.

MAGNETISM.

5. ***On the Dip of the Needle and the Intensity of the Magnetic Force.***—The following observations on the dip of the needle and the intensity of the magnetic force, have been collected and calculated by Professor Hansteen.

	Dip.	Intensity of the Magnetic Force.		Dip.	Intensity of the Magnetic Force.
Peru,	0° 0	1.0000	**Hare Island,**	82° 49′	1.6939
Mexico,	42 10	1.3155	**Davis' Straits,**	83 8	1.6900
Paris,	68 38	1.3482	**Baffin's Bay,**	84 25	1.6685
London,	70 33	1.4142	——— ——	84 39	1,7349
Christiana,	72 30	1.4959	——— ——	84 44	1.6943
Arendahl,	72 45	1.4756	——— ——	85 54½	1.7383
Brassa,	74 21	1.4941	——— ——	86 9	1.7606

6. *Magnetic Equator.*—M. Morlet, in a Memoir on Terrestrial Magnetism, has shewn that the magnetic equator cuts the terrestrial equator *twice*, and is *once* a tangent to it. It undergoes different inflexions, and does not deviate more than 14° or 15° on either side of the line.

HYDRODYNAMICS.

7. *Dr Coate's Hydrostatical Balance.*—The object of this instrument is to ascertain the specific gravity of minerals, &c. without the aid of calculation. It is nothing more than a common steelyard, the shorter arm of which is undivided, while the longer arm has engraven on it a scale, every division of which, reckoning from the extremity of the steelyard, is marked with a number which is the quotient of the length of the whole scale, divided by the distance of the division from the end. Thus, 2 is placed at half the length, 3 at one-third of the length, and so on, up to the specific gravity of platinum. When the instrument is used, any convenient weight is suspended by a hook from the notch at the end of the longer arm. The mineral is then hung at the other end by a horse-hair, until it is in equilibrio with the weight. It is then immersed in water, without changing its place on the steelyard, and an equilibrium is obtained a second time by shifting the weight; and when this is obtained, the hook of the weight will point out the specific gravity on the scale.

8. *Velocity of Fluids.*—It appears from the experiments of M. Lehot, that the adhesion of water and alcohol to glass diminishes in proportion as the temperature is increased; and that under the same pressure, a jet of water which escapes by a vertical capillary tube will rise higher as the temperature becomes greater.—*Bibl. Univers.* Mars 1820, p. 225.

METEOROLOGY.

9. *Paraselene seen at Liverpool.*—This rare meteor was observed by Dr Traill at Liverpool, on the evening of the 30th of March 1820, about 10 o'clock. The moon was then about 35° above the southern horizon. The atmosphere was nearly calm, but rather cloudy, and obscured by a slight haze. A wide halo, faintly exhibiting the prismatic colours, was described round the moon as a centre, and had a small portion of its circumference cut off by the horizon. This circular band was intersected by two small segments of a larger circle, which, if completed, would have passed through the moon, and parallel to the horizon. These segments were of a paler colour than the first mentioned circle. At the points of intersection appeared two pretty well defined luminous discs, equalling the moon in size, but less brilliant. The western paraselene had a tail or coma, which was directed from the moon. The coma of the eastern paraselene was much less distinctly marked, and was soon lost in the adjoining segment of the larger circle How long the meteor lasted is not ascertained. Dr Traill's attention was directed by a friend to an unusual appearance in the sky about 10 o'clock; and then these phenomena were visible to him and several other individuals for above half an hour. The whole gradually faded away. The accompanying figure, Plate IX. Fig. 11. will give a tolerable idea of the meteor.

10. *Meteoric Stones in the Form of Leaves.*—A meteoric substance like black paper is said to have fallen near Randen in Courland, on the 31st January 1686. This fact led M. Von Grotthus to recognise it in a substance in his own museum, which had a label attached to it, stating it to be of meteoric origin. It is a mass of black leaves resembling burnt paper; but it is harder, brittle, and coheres together. It has been found to consist of silica, magnesia, iron, some nickel, and traces of

chromium, the same ingredients as those of meteoric stones.—*Ann. of Phil.* No. 91. p. 68.

11. *Delcross's Observations on Hail.*—During ten years, M. Delcross had observed that hail consisted of spherical pyramids or fragments of spheres, which had been broken by some explosion, and the cleavages of which always passed through the centre of the sphere. He frequently looked in vain for the original sphere, but never observed it till the 4th July 1819, during the dreadful hailstorm at Baçonniere. Some of the spheres were fifteen inches in circumference.—*Biblioth. Universelle*, Feb. 1820, p. 154.–157.

12. *Height of Meteors from which Meteoric Stones are projected.*—According to the observations of M. H. Dutrochet, the height of the meteor which projected the meteoric stones at Charsouville, in the department of the Loiret, on the 23d November 1810, was about 14,724 toises. Mr Bowditch found, that the perpendicular altitude of the meteor which discharged the meteoric stones at Weston in North America, on the 14th December 1807, was 15,360 toises, or about 16 miles.—*Journ. de Physique*, Mars 1820, tom. xc. p. 227.

II. CHEMISTRY.

13. *Five New Alkaline Bodies.*—M. Van Mons has announced, that Dr Brandes has discovered new alkalies in the following plants, viz. *Datura stramonium*, *Hyoscyamus niger*, *Aconitum napellus*, *Atropa belladonna*, and *Cicuta virosa*. The alkali from the Atropa he has found to constitute the ingredient which gives that plant its peculiar properties. Its colour is brilliant white. It crystallises in long needles; is tasteless, and slightly soluble in water and alcohol. It withstands a moderate heat. It forms with acids regular salts, and neutralises a considerable proportion of acid. *Sulphate of atropia* consists of

Sulphuric acid,	36.52
Atropia,	38.93
Water,	24.55
	100.00

Atropia and potash mixed together and exposed to a red heat, yield ashes, which, when mixed with muriate of iron, strike a lively red colour. The alkali from the *Hyoscyamus niger*, even when heated to redness with charcoal, is not easily altered. It crystallises in long prisms, and when saturated with sulphuric acid, and especially with nitric acid, forms very characteristic salts.—See *Journ. de Pharm.* and *Ann. of Phil.* No. 91, p. 69.

14. *Curious Experiment with Iodine.*—According to Van Mons, if we dissolve some iodine in muriatic acid, and pour ammonia over the solution, so that the two liquids do not mix, the iodine will in a short time crystallise between the two liquids, in fine pyramids, having their bases turned towards the surface of the liquid.

15. *Native Combination of Sulphate of Barium and Fluoride of Calcium.*—This singular substance, obtained in Derbyshire many years ago, has been recently examined by Mr Smithson. It formed a vein about an inch wide in a coarse shell-limestone. Next to this substance was a layer of crystals of sulphuret of lead; and between these and the limestone-rock, a layer of crystals of carbonate of calcium. This compound substance is so like fine compact grey limestone, that the eye cannot distinguish them. Its specific gravity is 3.750, and it consisted of

Sulphate of barium,	51.5
Fluoride of calcium,	48.5
	100.0

"This mineral," says Mr Smithson, "presents us with a remarkable case of combination, that of a neutral salt with a body which is not a salt, but belongs to an order which is analogous to metallic oxides. I have met with another instance of the kind. I have examined transparent crystals composed of anhydrous sulphate of calcium, and chloride of sodium."—*Ann. of Phil.* No. 91. p. 49.

16. *Flame of Hydrogen rendered luminous.*—Dr Hare of Philadelphia has rendered the flame of hydrogen luminous like that of oil, by adding a small quantity of oil of turpentine to the usual mixture for generating that gas. The light seems greater than that of carburetted hydrogen. He found also that the ad-

dition of $\frac{1}{17}$th of oil of turpentine to alcohol, gives this fluid the property of burning with a highly luminous flame, and that there is a certain point in the proportions, when the mixture burns without smoke, like a gas light. Silliman's *American Journal of Science*, vol. ii. p. 172.

17. *Imitations of Meteoric Iron.*—In order to imitate the Siberian meteoric iron, Mr Stodart and Mr Faraday fused some horse shoe-nails with 10 *per cent.* of nickel. The metals were found perfectly combined, and when polished, it had a yellow tinge. It was less rusted in a moist atmosphere than pure iron; but what was very singular, the same quantity of nickel, when alloyed with *steel*, accelerated its rusting instead of preventing it. *Journ. of Science*, N° 18. p. 325.

18. *Method of making Wootz.*—The following method of making wootz is given in the paper just quoted. Pure steel in small pieces, or good iron mixed with charcoal powder, were heated intensely for a long time, and formed highly crystalline carburets, composed of 94.36 iron, and 5.64 carbon. This being broken, and rubbed to powder in a mortar, was mixed with pure alumine, and the whole intensely heated in a close crucible for a considerable time. The result was a brittle alloy of a white colour, and close granular texture, consisting of 6.4 *per cent*. alumine, and a portion of carbon. When 700 grains of good steel, and 40 of the alumine alloy, were fused together, they yielded a good malleable button, which being forged into a bar, and polished, gave, by the application of diluted sulphuric acid, the beautiful damask which is peculiar to wootz; and which wootz retains even after repeated fusions. A second specimen obtained from 500 grains of the same steel, and 67 of the alumine alloy, possessed all the appreciable characters of the best Bombay wootz. *Journ of Science*, No. 18. p. 320.

19. *Developement of Heat by freezing.*—H. T. de la Beche, Esq. has published in the *Bibliotheque Universelle*, for January 1820, p. 6. an ingenious method of exhibiting the heat which is developed by water during congelation. Having placed two parts of olive oil above one of water, in a glass phial, he exposed it to a temperature of 11° of Fahrenheit. In a short time the temperature of the water descended below 32°, but re-

ascended to it at the instant of congelation. The oil, however, remained liquid, though exposed to a degree of cold much greater than that at which it freezes, and did not freeze for two or three hours after the water appeared to be frozen. This effect was owing to the disengagement of the latent heat of the water, during its conversion into ice.

20. *Antidote against Corrosive Sublimate.*—In the course of his experiments on gluten, Dr Taddei found, that wheaten flour and gluten, reduced corrosive sublimate to the state of calomel, and that considerable quantities of a mixture of flour or gluten, with corrosive sublimate, might be taken by animals without any injurious effects. In this way, fourteen grains of sublimate were given in less than twelve hours to rabbits and poultry without injury, whereas a single grain would have been fatal, if taken alone. In order to render a grain of the corrosive sublimate innocent, 25 grains of fresh gluten, or 13 of dry gluten, or from 500 to 600 grains of wheaten flour are necessary.—*Giornale di Fisica*, ii. p. 375.

21. *Chrome the characteristic ingredient of Meteoric Stones.*—Nickel has hitherto been considered as the most characteristic ingredient of meteoric stones, because it has been found in considerable quantity, and has also been met with in meteoric iron. As chrome was not found in the meteoric stones which fell at Stanneren in Moravia, it has been regarded as less characteristic of them than nickel. M. Laugier, however, has found, that the meteoric stone which fell at Jonzac on the 13th June 1819, *contained no nickel*, as appears from the following analysis:

Oxide of Iron, - -	36
Silex, - - -	46
Alumine, - - -	6
Lime, - - -	7.50
Oxide of Manganese, - -	2.80
Magnesia, - - -	1.60
Sulphur, - - -	1.50
Chrome, - - -	1
	102.40

In re-examining the stone which fell in Moravia, he has also ascertained that it *actually contains a half per cent of chrome*; and hence he concludes, that in so far as our knowlege goes, chrome should be considered as the most constant ingredient of meteoric stones. *Journal de Physique*, Avril 1820. tom. xc. p. 312.

22. *Muriate of Potash in Rock-Salt.*—M. Vogel has discovered that muriate of potash exists in rock-salt, and in common salt extracted from brine springs. See Gilbert's *Annalen*, LXIV. p. 157.

23. *Benzoic Acid.*—M. Vogel has discovered benzoic acid in a crystallised state between the skin and the kernel of the *Tonquin bean* (from the *Dipteryx odorata* of Willdenow.) He also found this acid in the flowers of the *Trifolium melilotus officinalis*, in such quantity, that he thinks it might be profitably extracted from them for the purposes of sale. See Gilbert's *Annalen*, LXIV. p. 161.

III. NATURAL HISTORY.

MINERALOGY AND GEOLOGY.

24. *New Ores of Lead.*—We have stated in an account of some new ores of lead, published in last N°. p. 138. that Dr Fyfe found one of them to be a *sulpho-carbonate* of lead, and we stated, out of justice to that chemist, that he communicated this fact to us on the 6th of March. We understand that Mr Brooke's experiments on " Three new species of Lead-ore" were made in 1819, long before any experiments were made in Scotland; but even if this had not been the case, the single experiment made by Dr Fyfe could never have been regarded as interfering with the right of Mr Brooke to be considered as the first who determined these specimens to be new ores. We have some reason, however, to think that the ores examined in Edinburgh are not the same as those described by Mr Brooke.—D. B.

25. *Wahlenberg's Geology of Sweden.*—This celebrated Swedish botanist has for some years past devoted his time to the study of geognosy; and in the summer of 1817, he made a geological survey of the southern part of Sweden. Lately he has published in the Acta Upsalienses, a masterly memoir on the petrifactions of Sweden, particularly descriptive of those met with in transition rocks. He has also published, as a prodro-

mus, an essay on the general geognostic structure of Sweden, which displays his usual acuteness and sagacity.

26. *Diminution of the Waters of the Globe.*—Mountains having been conjectured to be formations from a state of solution in water, it has been inquired, "What has become of the vast body of fluid which formerly covered the earth, and stood over even the highest mountain peaks?" The following statement it is presumed may remove some of the difficulties attending this question. Salts, when crystallizing from a state of aqueous solution, are not confined to the surface of the liquid, but frequently rise above it. This effect being considerable in the small scale in our soda cisterns, how much more striking must it not have been during the crystallization of mountains. If crystals in a soda cistern shoot an inch above the surface of the solution, it cannot excite surprise if, in the vast primeval fluid, crystallizations have in this way risen many thousand feet above the level of the fluid. If this be admitted as a fair inference, it will go far in assisting us to explain what has been called the diminution of the original waters of the globe.

27. *Relief Globe.*—Charles P. Khummer, an artist of Berlin, has lately published a globe, in which the mountains are beautifully executed *in relief.* It is admirably calculated for communicating lasting and accurate ideas of the distribution and grouping of the great ranges of mountains, and table lands in the different quarters of the globe. There are globes of this description of different sizes and prices. Globe, 16 inches in diameter, 8 dollars, without names,—with names 11 dollars. Globe 26 inches diameter, 25 dollars, without names,—with names, degrees, and finely finished, 50 dollars.

28. *Pansner on the Fall of the Wolga.*—In a paper of Dr Pansner's in the 6th Number of the Petersburgh Journal, "On the difference of height between Ostaschkow and Astrachan, or the fall of the Wolga between these two places," we find the following facts. From numerous observations made by M. Von Pansner, it appears, that Astrachan is situated 155.13 French feet *below* the level of the sea. The lately published observations of the academician Inochodzow at Kamüschen on the Wol-

ga, which is 568 wersts from Astrachan, prove that it is 189 English feet below the level of the barometer at St Petersburgh. Now, as Petersburgh is 65.24 French feet above the level of the sea, Kamüschen must be 112.1 lower than the surface of the sea. From this it follows, that the idea of a subterranean communication with the Caspian, and the higher lying Black Sea, is absurd. M. Von Pansner records another calculation, which also proves that Astrachan lies lower than the level of the sea. M. Inochodzow says, Nikolajew is 28.462 French feet lower than Petersburgh: if Petersburgh is 65.244 French feet above the level of the sea, Nikolajew is 36.782 French feet above the level of the sea. But Astrachan is 155.128 French feet below the level of the sea: Therefore Nikolajew is 191.910 French feet above Astrachan.—It also follows, from the observation of Dr Haas (Ma Visite aux Eaux d'Alexandre en 1809 et 1810, Moscow, 1811, p. 115.–120.), that Neutscherkask lies 192.841 French feet above Astrachan. But from Neutscherkask to the Black Sea, the fall of the River Don is scarcely more than 8 feet. So that the Black Sea must be at least 185 feet higher than the Caspian Sea. Pallas in his Travels speaks of the comparatively low level of the surface of the Caspian, when contrasted with other lakes. Engelhardt and Parrot, in their late Travels in the Crimea and the Caucasus, say that the Caspian is 304.8 French feet lower than the Black Sea. These facts contradict the groundless opinion of Reinegg, as stated in his Topography of the Caucasus, that the situation of the Caspian Sea is much higher than that of the Black Sea. M. Pansner, from numerous barometrical observations, infers, that Ostaschkow is 802.84 French feet above the level of the sea; but Astrachan is 156.13 French feet below the level of the sea; so that the relative height between Ostaschkow and Astrachan, or the fall of the Wolga, is 957.97 French feet. Pansner concludes his memoir with the following remark: "Geognostically considered, the Mons Alaunus of the ancients, the *Height of the Wolga* of modern geographers, is nothing more than a gentle inclined rising ground, intersected by numerous rivulets. The only rocks are those of the secondary and alluvial classes; and the surrounding flat country is covered with fine sea sand and numerous boulders, resembling those scattered along the shores of the Baltic. These facts prove, that this place, in former times, when covered with the waters of the ocean, was nothing more than a submarine shallow; and thus destroy the idea of a broken chain of granite fancied by some travellers. This height, however, is interesting to the geologist, on account of its being one of the highest points in the north of Europe, containing petrifactions of sea animals. The greatest height I met with in this district, during my journey in August 1807, is between the towns of Ostaschkow and Waldai, 1211.97 French feet above Astrachan, which is 1050.84 above the level of the sea."

29. *New Works on Petrifactions.*—1. The well known geologist, Baron Von Schlotheim, is just about to publish an extensive work on petrifactions, and, judging from the accuracy and extensive knowledge of the author, it cannot fail to prove a valuable addition to this interesting branch of natural history. 2. Emmerling, the mineralogist, has also announced a work on the fossil organic remains met with in brown coal, and other new formations of the same description. 3. There has just been published at Leipzig, a work in folio, with numerous plates, entitled Geognostical Flora of a former world, by Graf Kasper von Sternberg. From the plates of this work, sent to the Wernerian Society by Count Breunner, the drawings appear to be faithfully executed, and many of the objects represented are of the same description with those so abundantly distributed in our coal-fields.

ZOOLOGY.

30. *Ursus longirostris* (*Ursine Sloth*, Shaw.)—In the year 1792, there was shewn in London, under the name *Lion-monster*, an unknown animal from the neighbourhood of Patna in Bengal. Pennant and Shaw who examined it, said it had grinders and canine teeth, but no fore-teeth, and hence they referred it to the genus Bradypus or Sloth, and from its general resemblance to the bear, named it *Ursine Sloth*. This erroneous opinion was adopted by several succeeding naturalists. Illiger referred it to the family Tardigrada, considering the description of Pennant and Shaw as correct; but on account of the form and number of its teeth, and the form of its claws, he separated

it from the genus Bradypus, and described it as a distinct genus under the name Prochilus, from its remarkably moveable and extensile lip. It is also mentioned by Cuvier; but he hesitates as to its true place in the system, and remarks, that the form of its teeth does not agree with those of the sloth tribe. Very lately, Tiedemann, the celebrated comparative anatomist, had an opportunity of examining a live specimen of this curious animal, and was thus enabled to refer it to its true place in the system. He finds that it is provided with cutting teeth, and belongs not to the sloth, but to the bear or ursus tribe. The following is his description, " Ursus longirostris: naso elongato; labiis protensilibus; corpore pilis longis, densis et nigris tecto: collo macula alba cordiforme ornato." According to Dr Francis Hamilton, it lives in holes which it digs, and subsists on fruits, sorgho, and white ants.

31. *Account of a vessel struck with a Sword-fish.*—A vessel which arrived at Liverpool about a year ago, (the Kitty, Captain Hodson,) from a voyage to the coast of Africa, being put into the graving-dock for the purpose of receiving some repairs, was found to be perforated through the *bow*, by a hard bony substance. This substance, probably a part of the rostrum of a Xiphias or Sword-fish, had penetrated through a solid part of the vessel, where the thickness in timber and planks was 12 inches of sound oak. The shattered end of the bone was visible on the outside, and the smaller extremity appeared within the ceiling. The latter part being observed by a carpenter, who mistook it for a trenail, he struck at it a blow with a mallet, by which a portion of the tip was broken off. Finding it to be something curious, he pointed it out to Messrs J. and R. Fisher, shipbuilders, the owners of the vessel, who caused it to be taken out. The position of the bone was at the distance of four feet, horizontally from the stem, and two feet below the surface of the water when the vessel was afloat. Hence, it appeared, that when the ship had been in rapid progress through the water, she had been met and struck by a sword-fish advancing in an opposite direction, by the shock of which, or by the action of the water forced past the body of the animal by the vessel's progress, the snout had been broken off and detached. The blow, though it must have been singularly forcible, was not ob-

served by any person in the ship. Had the bone been withdrawn, the vessel would probably have foundered. The substances through which it had penetrated were, a sheet of copper, an oak plank $2\frac{1}{2}$ inches in thickness, a solid oak timber of $7\frac{1}{2}$ inches, and another plank also of oak, of 2 inches. The bony substance, which, through the politeness of Messrs Fisher, I was allowed to examine, is $15\frac{1}{2}$ inches in length, $2\frac{1}{2}$ inches greatest diameter, and weighs 1 lb. 2 oz. It is nearly cylindrical at the point, but considerably compressed towards the root. The longest and shortest diameters in the middle, are respectively $1\frac{7}{10}$ inches and $1\frac{1}{10}$; and in the thickest part, near the extremity, 2 inches and $1\frac{3}{10}$. Most of the surface is rough, the colour grey, the fracture splintery. The roughness, which extends all round the bone to the distance of 5 or 6 inches from the point, and indeed all over it, excepting on a part of the surface, consists of minute tubercles or denticles, imbedded in a substance having the appearance of an incrustation of the thickness of a shilling. Some of the tubercles are wanting, but their cavities remain visible. Whether these tubercles are natural to the substance on which they are found, or whether they are the incrustation of a species of sertularia, I had not an opportunity of determining. That part of the surface which is free from any denticles, appears of a fibrous bony texture. The broken extremity is hard, white, and splintery in the fracture. In the interior of the bone are four angular perforations, running longitudinally almost as far as the very tip; they are from $\frac{1}{10}$th to $\frac{1}{5}$th of an inch in their largest diameter.—*Wm. Scoresby* jun.

32. *Propagation of the common Earth-Worm.*—Swammerdam says, that the common earth-worm is first extruded in the form of ova or eggs, while many later writers, on the contrary, maintain, that they are viviparous or produce living young. In an excellent inaugural thesis by Dr Leo, on the structure of the Lumbricus terrestris, published in Germany, the old opinion of Swammerdam is confirmed, and the accuracy of Dr Leo's observations has been confirmed by the approval of the celebrated Rudolphi.

33. *Preservation of Eggs.*—As it is of great importance in a zoological, and even in an economical view, to be able to transport

eggs fresh from one country to another, it has been proposed as the best mode of effecting this, to varnish them with gum-arabic, and then imbed them in pounded charcoal. The gum-arabic answers better than varnish, as it can be easily removed by washing in water, and the bed of charcoal, by maintaining around the eggs a pretty uniform temperature, prevents them from suffering from the great alternations of heat and cold, experienced in carrying them to different countries.

BOTANY.

34. *Nature of Hard Woods.*—We have already alluded to the remarkably abundant formation of calcareous earth in the genus Chara, and in that curious tribe of vegetables so often considered as of animal origin, and named Corallina. Other plants are particularly distinguished by the quantity of silica they secrete, and of these, the best known are the rush and the bamboo. Masses of silica of considerable magnitude have been cut out of the teak-wood; this circumstance, conjoined with the hardness and weight of the wood, led Professor Jameson to conjecture, that the teak, and other similar woods, might contain silica, or even adamantine carbonaceous matter. This conjecture has been confirmed in part by the experiments on teak made by Dr Wollaston, on the suggestion of Professor Jameson, who found that it contained a considerable portion of silica, and similar results have been since obtained by Mr Sivright of Meggetland, of which an account was lately communicated to the Wernerian Society.

35. *Uses of Iceland Moss.*—The esculent properties of the Iceland lichen are well known in many districts on the Continent of Europe. Of late years it has been proposed to use it either alone or mixed with flour in the composition of bread in those districts where flour is scarce. The Saxon Government lately published a Report on this subject, which is full of information interesting to those mountainous districts, where this plant abounds. In this report, we are informed, that 6 pounds and 22 loth of lichen meal boiled with fourteen times its quantity of water, and baked in this state with 59½ pounds of flour, produced 111½ pounds of good household-bread. Without this addition, the flour would not have produced more than

78¾ pounds of bread; consequently, this addition of 6 pounds and 22 loths of lichen meal has occasioned an increase of 82⅚ of good bread. It is known, that 3 pounds of flour yield 4 pounds of household bread. One pound of lichen meal, added in the form of paste, gives an addition of nearly 6 pounds, and therefore is equivalent in this view, to about 3¾ pounds of flour, because it affords above 3½ times more bread than this. But at present nearly all the Iceland moss collected in Germany, is sent through Hamburgh to England, where it is used in brewing, and in the composition of ship-biscuit, as it is said biscuit which contains it as a constituent part is not attacked by worms, and suffers little from the action of sea-water. This lichen, when deprived of its bitter principle, forms an excellent soup, and when coagulated, a good jelly; and it has been recommended in this prepared state as an excellent substitute for sago, (the pith of the Cycas circinalis), salep, and even for chocolate.

36. *Plants which have been confounded with Animals.*—Professor Schweigger of Konigsberg, in a lately published, very amusing and interesting work, entitled "Beobachtungen auf Naturhistorischen Reisen," maintains, that several bodies described as zoophytes, are true plants, such as Corallina, and several other genera. He examined the *Corallina Opuntia* in different stages of its growth, and found it had the vegetable structure, and that its calcareous crust was formed in the same manner as is observed in the vegetable genus Chara. The *Corallina rubens* he also discovered to be a plant; and proved the same to be the case with the *Corallina officinalis*, that species so frequently met with in the Frith of Forth, and all around the coasts of this island. The *Millepora coriacea*, from observations detailed in the work, appears also to be a calcareous plant; and Schweigger is of opinion, that all the species of the Lamarckian genera *Corallina*, *Pincillus* and *Flabellaria* are of the same description. The *Alcyonium bursa*, which Linnæus ranges in the animal kingdom, is described as a fucus by Turner, under the name F[illegible] bursa, and the author of English Botany also figures [illegible]gamous plant, while Lamarck still retains it in t[illegible]s Alcyonium. Olivi describes it as a particular [illegible], under the title Lamarkia:

Lamouroux also maintains its vegetable nature, and describes it as a species of his genus Spongodium; and Schweigger proves, by numerous observations, its vegetable nature, and advises it to be placed between the genera Fucus and Conferva.

37. *Nocturnal Fragrance of different Plants.*—The peculiarity of plants which emit their aroma in the evening, has occupied so much the attention of botanists, and has given rise to so much discussion, that any novelty on the subject is not perhaps to be expected. Mr Johnson, Hill-Top, near Wetherby, has remarked, that the evening primrose *(Œnothera biennis)* an indigenous plant, which grows plentifully on some parts of the western shores of this island, particularly in Lancashire, and some of the counties of the principality, exemplifies this singularity. On a rampant and luxuriant plant, which he had in a large pot during the last summer, he made many observations. For an hour or more before sunset, he noticed that the flowers appeared just ready to burst, and that soon after the twilight commenced, they opened most rapidly, and sometimes with a motion or jerk, extremely distinct. The delicate odour was faintly perceptible, as soon as the petals were fully expanded, but became much more pungent, when the evening was farther advanced, and then at intervals could scarcely be perceived, but was soon emitted again additionally powerful. The *Œnothera pumila*, and the beautiful Brazilian *Œ. longiflora*, have both the same property of expanding their flowers in the evening, but on these he has not made any particular observations. The beautiful and delicate tuberose, *(Polianthes tuberosa)*, so much prized for its elegant flowers and charming fragrance, may also be adduced as an example of the subject under consideration. Mr Johnson had, last July, a fine plant, about five feet in height, in blossom, in a room, which he observed emitted its effluvium most strongly after sunset. One sultry evening, after thunder, (it is believed the 16th July, on which day the thermometer stood at 81° in the shade,) when the atmosphere was evidently highly charged with the electric fluid, Mr Johnson was surprised at seeing small sparks, or scintillations of a lurid flame colour, darted with apparently excessive rapidity and momentum, from two or three of the expanded flowers, which were beginning to fade, and at the same time the odour

was so powerful, as to be palling and unpleasant. He could not perceive any difference in the strength of the odour at different intervals, but during the whole evening its intensity seemed to be equable. He has subsequently noticed, that the smell from the flower is most diffused in the light, but he has not again observed the singular electric phenomenon, though he has nightly and attentively looked for it. During the time of the appearance of the flashes or sparks, he was anxious to know whether their emission were attended by a crackling or snapping noise, as is the case when the electric spark is elicited from a charged jar; but though he was most attentive, he was not conscious of hearing the least noise. The *Daphne Pontica*, a hardy evergreen, originally brought from the Levant, but now common in our gardens, is another "Nightingale of the vegetable race," which, when in bloom, is very fragrant in an evening, especially when the air is moist; indeed, a humid state of the atmosphere seems favourable to the emission of their effluvia by different plants; hence we find that mignonette *(Reseda odorata)*, wall-flowers *(Cheiranthus cheiri)*, &c. are peculiarly sweet after showers.

IV. GENERAL SCIENCE.

38. *Proposal to winter in Spitzbergen.*—It is much to be regretted, that hitherto no scientific account has been published of the winter climate of Spitzbergen; and this seems to have been owing principally to the circumstance of the persons who wintered there at different times being uneducated and unprovided with instruments for making observations. One of our scientific correspondents, who has visited Spitzbergen, writes to us, "It is to be regretted, we have not a regular register of a winter in Spitzbergen. I think, if properly gone about, it might be accomplished with little hazard, notwithstanding the direful accounts given by those who have passed a winter there. It is an undertaking which I would join in with very great pleasure." The gentleman who makes this proposal, we know, is well qualified for such an undertaking.

39. *Russian Expedition into the Frozen Ocean, by Lieutenant Lasarew, in the year* 1819.—The Russian Lieutenant La-

sarew, who last year performed a voyage into the Icy Sea, in the ship Nowaga Sema, has just published an account of his proceedings. The vessel was fitted out at Archangel. The crew consisted of fifty men, besides officers. The ship left Archangel on the 9th June old style. Her destination was the Strait of Waigatz, and from thence around the coast of Nova Zembla. After overcoming the greatest difficulties, owing to the enormous accumulation of ice, they reached the entrance of the Strait of Waigatz, on the 27th July; but the same cause prevented them landing on the coast. The perpetual fog and intense cold had a most pernicious effect on the health of the crew. Not a trace of vegetation could be seen, the land every where appearing deeply covered with snow. It seemed as if the ice was now more accumulated here than in former times, because the Russian huntsmen have for several years abandoned their pursuit of the white bear in Nova Zembla. The vessel, after having reached 73° 2′ N. Latitude, and 58° 8′ E. Long. from Greenwich, and determined some points in the coast, was forced to return to Archangel, as the season for sailing in those dreary regions was at an end. Several of the crew died on the way; and on their arrival in Archangel, on the 4th September old style, only six of the crew were able to do duty,—the officers being obliged to assist in navigating the ship.

40. *Expedition of Discovery in America.*—Messrs Roberts and Henry, both Welchmen, and well acquainted with the language both of North and South Wales, have undertaken an expedition to the country comprehending all the southern ramifications of the great river Missouri, for the purpose of ascertaining the existence of a race reported to be the descendants of certain Welch emigrants. *Gazette of St Louis.*

41. *French Expedition of Discovery.*—The French ship of discovery Urania, under Captain Freycinet, was wrecked on the 14th of February 1820, by striking against a submarine rock at the mouth of French Bay, Falkland Islands. All the crew, and all the papers, and objects acquired during the expedition, were fortunately saved. M. Freycinet has, no doubt, arrived ere this in France, and we look forward with much interest to the publication of the account of his voyage. His mag-

netical observations will, we understand, be particularly valuable.

42. *Heights of different Points of the Chain of Jura.*—The following are the results obtained by M. Roger from a geometrical survey of the Jura. The altitudes are reckoned from the Lake of Geneva, which is 372.93 metres, or 1151.1 Paris feet above the sea.

	Metres.	Paris Feet.
Toiri, - - -	1344.8	41389
Grand Colombier, - -	1315.25	40489
Montendre, - -	1308.00	40266
Dole, - - -	1305.00	40174
Crêt de la Gutte, - -	1247.61	38407
Chasseron, - - -	1236.23	38057
Suchet, - - -	1215.94	37432
Dent de Vaulion, - -	1111.27	34210
Col du Marchairu, - -	1088.09	33368
Passage des Rousses, -	868.25	26728
Lac de Joux (mean state of the water),	633.05	19488
Hill of the Tower of Gourze, -	543.84	16742
Passage of Chalet Gobet, -	492.00	15146
Lausanne, House of Baron de Falckensfield, on the level of the street,	124.00	33817

Bibliotheque Universelle, Fev. 1820, p. 94.

43. *Temperature of the Lakes of Thun and Zug.*—Mr de la Beche has obtained the following results in measuring the temperature of the lakes of Thun and Zug.

	Fahr.			Fahr.
Lake of Thun, surface	60°	Lake of Zug, surface,		58°
15 fathoms,	42	Zug,	15 fathoms,	42
50	41½		25	41
105	41½		38	41

Bibl. Universelle, Juin 1820, p. 144.

44. *Singular discovery respecting Copper-plate Printing.*—M. Gonord is said to have excited the surprise of the public, by announcing that he can take impressions from an engraved copperplate on any scale, either larger or smaller than the plate,

without requiring another copper-plate, or occupying more than two or three hours. For example, from the large atlas engravings of the Description de l'Egypte, he could make an edition in octavo without changing the plates. The certainty of the process has been corroborated by the members of the jury admitted into his works; and the jury, in consequence, decreed a gold medal to M. Gonord. *Ann. de Chim.* XIII. p. 95. This discovery, if there is no mistake about it, must be considered as one of the most surprising that has ever been made in the arts. We can see no reason why stereotype plates, or pages of types, should not be employed to yield duodecimo and folio editions of the same work, and why the same die should not be employed in coining farthings as well as crowns.

45. *Extraordinary diversity of colours used in Mosaic work.* —In an extract from Mr Cadel's Travels, in a former number of this Journal, an account is given of the manufacture of Mosaic, in which it is stated that 17,000 tints of colour are employed in imitating the finer paintings. In a very amusing work of the celebrated Göthe, entitled "Winkelmann und sein Jahrhundert;" it is stated that about 15,000 varieties of colour are employed by the workers in mosaic in Rome, and that there are 50 shades of each of these varieties, from the deepest to the palest, thus affording 750,000 tints, which the artist can distinguish with the greatest facility. We should imagine, with the command of 750,000 tints of colour, that the most varied and beautiful painting might be perfectly imitated; yet this is not the case, for the mosaic workers find a want of tints even amidst this astonishing variety.

46. *Population of Van Diemen's Land.*—The total population of Van Diemen's land in 1819 was about 4360 persons; the free persons being 2074, and the convicts 2289. The whole number of acres in cultivation was 8330. The number of horses was 366; horned cattle 23,124; and sheep 172,128. There were 10 schools on the island, and 220 scholars. *Asiatic Journal*, N° 57. p. 220.

Art. XXX.—*List of Patents granted in Scotland since 30th May* 1820.

7. To William Kendrick of Birmingham, county of Warwick, chemist:—Invention of "The manufacture of a liquid from materials now considered useless for that purpose, and the application of the same liquid to the tanning of hides and other articles requiring such process." Sealed at Edinburgh 10th July 1820.

8. To William Erskine Cochrane of Somerset Street, Portman Square, county of Middlesex, Esq.:—Invention of "an improvement in the construction of Lamps." Sealed at Edinburgh 11th August 1820.

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